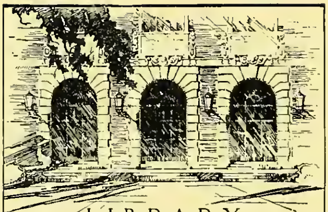

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Winter, 1959

ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

IN THIS ISSUE

One-row plow-plant machine used for studying effect of reduced tillage on corn yields (*see* page 3).

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ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

CONTENTS

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THIS FIRST ISSUE OF ILLINOIS RESEARCH

introduces a new service by your College of Agriculture. Its main purpose is to report, in a non-technical manner, the research being done by the Illinois Agricultural Experiment Station. We hope that farmers, homemakers, and workers in related fields will find much to interest them in these pages. It is hoped also that ILLINOIS RESEARCH will foster a closer acquaintance between our campus staff and the people of Illinois.

ILLINOIS RESEARCH will be published quarterly — in January, April, July, and October. Although it will not be possible to report on all phases of Experiment Station research in each issue, it is anticipated that, within the scope of a few issues, many of the major areas of study can be presented. Some general information about the College of Agriculture — including news of the Extension Service, activities of the students and teaching staff, and information about conferences, short courses, and other special events — will be included. ILLINOIS RESEARCH will not supplant the Experiment Station bulletins, Extension circulars, and other publications of the College of Agriculture.

This magazine is being sent to you because you have in the past expressed some interest in our publications. After you have had a chance to become acquainted with it, we will ask you to indicate whether you want to continue receiving it.

ILLINOIS RESEARCH is made possible through the cooperation of many interested staff members. They will be pleased to receive comments from you about this new venture. We are eager to make it as useful as possible and will be grateful for your constructive criticism. — *Louis B. Howard, Dean and Director*

A native of Illinois, Dr. Howard has been Dean and Director of the College, Experiment Station, and Extension Service since 1954. From 1948 to 1954 he was head of the Department of Food Technology, and from 1951 to 1954, he was Associate Director of the Experiment Station. Before 1948, he was chief of the Bureau of Agricultural and Industrial Chemistry, Agricultural Research Administration, U. S. Department of Agriculture.

MINIMUM TILLAGE

Reduces Work Without Reducing Yields

WENDELL BOWERS, H. P. BATEMAN, and JACK BAIRD

Reducing the number of trips over the field in preparing a seedbed for corn or soybeans will save time, labor, and production costs. But will these savings be offset by reductions in yield?

Agronomists and agricultural engineers at the University of Illinois have been conducting research on minimum tillage to find the answer to this question. Trials have been conducted at Urbana and at several other locations throughout the state.

The one-row plow-plant machine pictured on the cover and on page 4 has been used, as well as a variety of other equipment and methods. Among these are wheel-track planting, and plowing then planting with conventional equipment.

Results thus far have been encouraging. In 50 comparisons, plant populations obtained with minimum tillage have averaged 95 percent of those obtained with conventional tillage; and yields have been almost identical. Minimum-tillage yields have always matched conventional yields on soils with good tilth. There have been a few failures, particularly on fine-textured plastic soils that were drier than normal at planting time. This points up the importance of using the equipment necessary to insure a good seedbed in the row.

Wendell Bowers, Assistant Professor of Agricultural Engineering, became interested in minimum tillage research while working with Dr. S. R. Aldrich in 1956. The enthusiasm of Illinois farmers has been a reason for continuing the studies.

Experiments on University Fields

Minimum tillage research at the University of Illinois extends back to 1952, when H. P. Bateman inaugurated a study to compare basic tillage methods and their effects on corn yields and soil properties. This study was concluded in 1956. Average yields over the five years were nearly equal (Table 1). Although planting immediately after plowing reduced yields by 12 bushels in 1953, it gave 11 bushels more than conventional tillage in 1954.

Conventional equipment was used in these experiments. A clodbuster was pulled behind the plow the first three years, but after that the improved tilth from the reduced tillage made its use unnecessary.

The favorable results obtained from minimum tillage in these experiments were later confirmed by two years' trials on the soil experiment fields at Brownstown, DeKalb, and the Agronomy South Farm (Table 2).

Trials with soybeans at these three locations indicated that this crop, too, could be planted with minimum tillage without reducing yields (Table 2).

Trials on Illinois Farms

While minimum tillage appeared to be working successfully on the Agricultural Engineering Farm, there remained considerable doubt as to its practicality under actual farm conditions. The question was partly answered in 1956, when Dr. S. R. Aldrich tried plow-planting on eight different Illinois farms.

A one-row planter was mounted behind a three-bottom plow to provide a once-over operation for these trials. At only one location — in Piatt county — were yields significantly decreased by minimum tillage (Table 3). A yield reduction was predicted here at planting time, because the plastic, fine-textured soil made it difficult to obtain a good seedbed with the plow-plant machine. It was impossible to plant the seed to proper depth and get it covered. In all the Illinois trials, this was the only major failure of minimum tillage to match yields with those from conventional planting.

In 1958, minimum tillage was again tried on plastic, fine-textured soils similar to those encountered in the 1956 trial in Piatt county. This time, the trials were made on two farms in Christian county — one near Edinburg; the other, south of Assumption.

Equipment for plow-planting these two fields was almost identical to that used by Dr. Aldrich in 1956. The only differences were that weight was added to the press wheel, and that fins were used on the side of the runner instead of a depth plate, to give better tillage in the row.

On the Edinburg farm, both plow-planted and conventionally planted corn yielded about 125 bushels to the acre. On the Assumption farm, the yield from plow-planting was 28 bushels per acre higher than the yield from conventional planting where alfalfa had been the previous crop.

Table 1. — Corn Yields for Two Amounts of Tillage, Agricultural Engineering Research Farm, Urbana

Year and previous crop	Moisture at planting	Soil plowed plus	
		One disking	Planting only
		bushels per acre	
1952			
Clover	Adequate	94	92
Corn	Adequate	84	89
1953			
Clover	Very dry	73	61
Corn	Adequate	88	87
1954			
Corn	Adequate	89	100
1955			
Corn	Adequate	90	87
1956			
Corn	Adequate	124	125

This was in spite of considerable difficulty that had been experienced in adjusting the plow-plant equipment to obtain a good seedbed in the row. The soil on the conventional plot became very compacted; and this, coupled with a late July flood, appeared to give plow-planting the advantage.

General Observations

Several observations may be made from the various experiences we have had thus far with minimum tillage. One is that plant population is the most important single factor in obtaining maximum yields. A good seedbed in the row and planting ½ to 1 inch deeper than normal will help to insure adequate plant population. The need for deeper planting is due to rapid drying of the upper inch or two of soil. Germination was not seriously retarded in tests where corn was planted to a depth of 2½ inches or more.

Occasionally minimum-tillage corn would grow slower than conventional corn early in the season. At the same time, the minimum-tillage corn had a larger and more vigorous root system. This may have turned into an advantage near tasseling time, since minimum-tillage corn always overcame the early lag in growth.

Minimum-tillage corn yields have always matched yields from conventional planting as long as seedbed preparation and moisture in the row were sufficient to give adequate germination. But, while research results have been encouraging, don't go all the way on your farm until you have carefully analyzed your situation and have made some small-scale comparisons to determine which technique works best for you.

Table 2. — Corn and Soybean Yields With Minimum Tillage and Conventional Tillage at Three Locations; Two-Year Average, 1957-1958

Tillage method	Corn yields				Soybean yields			
	Browns-town	Urbana	DeKalb	Aver.	Browns-town	Urbana	DeKalb	Aver.
				bushels per acre				
Conventional	96	122	107	108	30	39	31	33
Plow and plant	93	119	105	106	32	42	32	35
Plow, spike-tooth, plant	95	122	108	108	31	41	34	35
Plow, wheel-track, plant	92	121	102	105	32	41	31	35

NOTE: Conventional tillage consisted of plowing, disking twice, harrowing, and planting. For wheel-track tillage, an automobile tire was mounted ahead of the planter shoe.

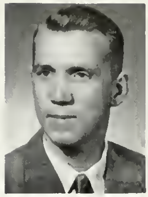
Table 3. — Corn Yields and Plant Populations With Plow-Plant and Conventional Tillage, 1956

Location	Soil	Plant population		Yield	
		Plow-plant	Conventional	Plow-plant	Conventional
				bushels per acre	
El Paso Woodford Co.	Elliott	12,500	......	106	...
Lowpoint Woodford Co.	Muscatine	11,000	15,300	100	111
Danville Vermilion Co.	Birkbeck	10,800	8,100	69	61
Chrisman Edgar Co.	Drummer	9,000	7,700	73	69
Shumway Effingham Co.	Cisne	11,400	11,400	139	129
Bement Piatt Co.	Drummer	9,600	13,300	89	121
Clinton DeWitt Co.	Flanagan	10,300	9,400	93	85
Roberts Ford Co.	Swygert	12,400	11,500	106	113

Successful minimum-tillage planting depends on a firm row, with good seed-soil contact. This was obtained with the plow-plant machine used in minimum-tillage experiments. A band spray attachment applied pre-emergence spray.

How NITROGEN BEHAVES in the Soil

New information about ammonium fixation may change our use of nitrogen fertilizers



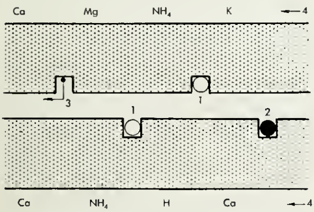
F. J. STEVENSON, author of this report, is Associate Professor of Soil Biology. He specializes in research on soil organic matter and soil nitrogen.

PLANTS USE larger amounts of nitrogen than of any other nutrient element. This of course means that nitrogen fertilizers must often be applied for top yields.

An understanding of how nitrogen behaves in the soil is the basis for an effective fertilization program. New information on this subject is resulting from research by the Department of Agronomy. In particular, we have been learning a good deal about ammonium fixation and its effect on the efficiency of nitrogen fertilization.

Two Forms of Nitrogen

Ammonium and nitrate are the two forms of nitrogen most commonly found in nitrogen fertilizers. Although they do not occur in such nitrogen fertilizers as urea and cyanamide, soil microbes convert these materials first to ammonium and then to nitrate. Anhydrous ammonia, a liquid under pressure, enters the soil as a gas, but is converted into ammonium as it comes into contact with the soil.



Location of nutrient elements held by a clay mineral:

1. **Fixed ammonium ions, showing close fit in the voids (pits) of the mineral. This nitrogen eventually becomes available to plants.**
2. **Potassium ion, also held snugly in the void of the mineral.**
3. **Calcium ion, too small to be fixed.**
4. **Readily exchangeable ions on clay surface.** **(Fig. 1)**

Ammonium and nitrate behave differently in the soil — which sometimes makes a difference in deciding which one to apply. Nitrate (NO_3^-) is a negatively charged ion that moves freely in the soil water and is readily available to crops. In the absence of a growing crop, it can be lost through leaching or denitrification (a process whereby the nitrate is changed into a form that can escape into the air).

Ammonium (NH_4^+) is a positively charged ion which exchanges with other ions on the surface of clay particles. As long as ammonium is held on the clay, it is non-leachable. However, under warm, moist, well-aerated conditions, it is readily converted into nitrate by soil microbes. For this reason, if you fertilize in the spring after the soil is warm, it makes no difference which type of fertilizer you apply — all forms of nitrogen end up as nitrate. If you fertilize in the fall or winter, however, it's usually better to use ammonium. For best results, apply the fertilizer *after* the soil has cooled to below 55° F. Soil microbes do not function effectively at low temperatures, and much of the nitrogen will remain in non-leachable form over the winter.

Ammonium can undergo another type of reaction with the soil — it may become fixed by clay minerals. That is, ammonium ions can be trapped in the pits or voids that make up the skeletal framework of the clay (Figure 1). Fixed ammonium ions are not easily exchangeable with other ions. Potassium can also be fixed by clay minerals. Calcium, magnesium, and other ions are not fixed because they are either too large to fit into the voids or so small that they move in and out easily.

Questions About Ammonium Fixation

In the experiments now being done on ammonium fixation, we are trying to answer these questions:

1. How much of the nitrogen in ammonium fertilizers becomes fixed by clay minerals?
2. How available is the fixed ammonium to plants?
3. Does the soil contain naturally occurring fixed ammonium?

Variations in Ammonium-Fixing Capacity of Illinois Soils

Our research thus far has been done in the chemical laboratory. At present we are unable to predict how much nitrogen will be fixed under field conditions. In the laboratory, Illinois soils vary in ammonium-fixing capacity from only a few pounds to several hundred pounds per acre-foot. Subsoils usually fix more ammonium than surface soils.

The ammonium-fixing capacities of several Illinois soils are given in Figure 2. Of all the soil types tested so far, Harpster has the ability to fix the largest amount of ammonium.

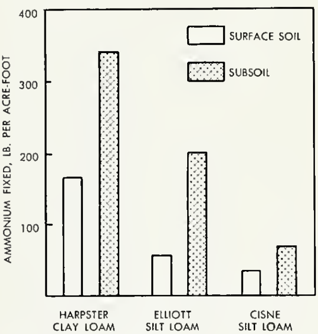
We have found that several factors affect a soil's ammonium-fixing capacity. One factor is the type and amount of clay minerals present. Soils with large amounts of illite generally fix more ammonium than those with large amounts of montmorillonite or kaolinite. Sandy soils, which contain little clay, fix practically no ammonium.

Ammonium-fixing capacity varies with the amount of potassium in the soil. If the voids of the clay particles are already filled with potassium ions, there is little or no room for the ammonium. This means that if you add potassium fertilizer *before* adding ammonium, less ammonium will be fixed than if the potassium had not been applied.

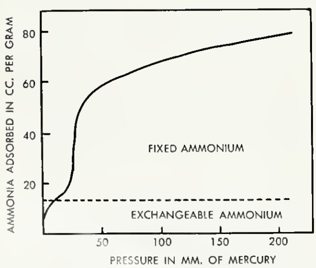
Some Illinois soils that now contain high amounts of native potassium will increase in ammonium-fixing capacity as cropping removes storehouse potassium.

The amount of ammonium fixed may vary with the type of ammonium fertilizer applied. Anhydrous ammonia is injected into the soil under pressure, which may force extra ammonium into the voids in the clay. The effect of pressure on the adsorption of ammonia by bentonite (a common soil clay) is shown in Figure 3. Ammonium was fixed even at pressures much below those used for injecting anhydrous ammonia into the soil. In this experiment, the ammonium fixed greatly exceeded that adsorbed on the external surface of the clay.

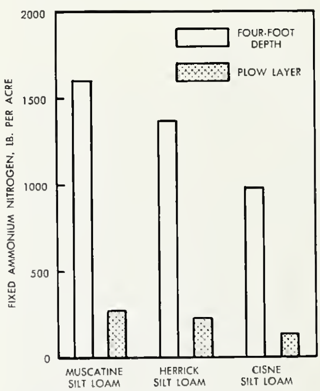
These results were obtained under laboratory conditions and we don't know yet what actually happens in the field. Even if ammonium is fixed under pressure in the field, this does not mean that anhydrous ammonia is inferior to other nitrogen carriers. Shortly we will see that ammonium fixation is really a favorable reaction.



Ability of some Illinois soils to fix ammonium *(data for Harpster partly from Allison, F. E., et al., Soil Sci. 72:187-200, 1951).* **(Fig. 2)**



Adsorption of ammonia on hydrogen bentonite, a common soil clay. Fixation occurred at pressures below those used for injecting anhydrous ammonia into the soil *(modified from Cornet, I., Jour. Chem. Physics 11:217-226, 1943).* **(Fig. 3)**



Fixed ammonium nitrogen in the plow layer and to the 4-foot depth in three Illinois soils. (Fig. 4)

Availability of Fixed Ammonium to Plants

All the ammonium fixed by clay minerals eventually becomes available to the plant. Research by many scientists indicates that most of the fixed ammonium is released during the season the fertilizer is applied. Some carry-over is expected, particularly if potassium fertilizer is applied right after the ammonium. This is because potassium acts as a lock on the clay minerals and prevents release of the fixed ammonium. As the potassium is removed by cropping, the fixed ammonium becomes available to the plant.

A Curse or a Blessing?

If the soil has more nitrate than plants can use, there is always danger that the excess will be lost through leaching or denitrification. Fixation of ammonium will prevent this loss and will insure a continual supply of nitrogen throughout the growing season. For this reason, we consider ammonium fixation a favorable effect. We think that our problem is one of finding out how to *increase* ammonium-fixing capacity — not how to *prevent* it.

Ways and means of increasing the ammonium-fixing capacity of soils have not been worked out, but when they are we will have gone a long way toward solving the nitrogen problem for Illinois soils. Research can provide the answer.

A Newly Found Form of Soil Nitrogen

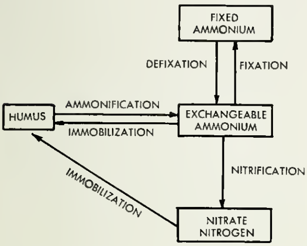
For many years, scientists assumed that the only mineral forms of nitrogen in the soil were exchangeable ammonium, nitrate, and nitrite (NO_2^-). Recently, however, University of Illinois agronomists have found that fixed ammonium occurs naturally in most soils, and that the amount is greater than the total for all the other mineral forms. Ammonium is a by-product of the decomposition of soil humus, so it shouldn't have been surprising to find naturally occurring fixed am-

monium. The amounts of fixed ammonium found in three Illinois soils are given in Figure 4.

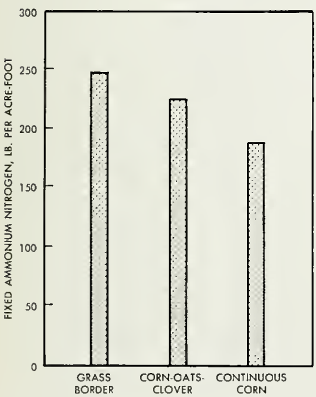
The availability of the soil reserve of fixed ammonium to plants is difficult to measure, since the amount present at any one time represents a balance between that being removed by plants and that being fixed from ammonium produced from organic matter. The relationship between fixed ammonium and other soil forms of nitrogen is given in Figure 5.

To see how cropping affects the levels of native fixed ammonium, we tested some soils from the Morrow plots at the University of Illinois. Soils tested were from a plot that has grown continuous corn without treatment since 1876; a plot that has been cropped to a corn-oats-clover rotation and received periodic applications of manure, lime, and phosphate; and the grass border surrounding the area (Figure 6). Losses in fixed ammonium did not keep pace with losses in organic matter (the continuous-corn plot contains less than half as much humus as the grass border). This is possibly due to fixation of some of the ammonium produced during decay of the organic matter. Also, native fixed ammonium may become available less easily than ammonium fixed from fertilizer.

We are continuing the work on the chemistry of nitrogen in soils. An understanding of the reactions of nitrogen in the soil will enable us to make more complete nitrogen fertilizer recommendations.



Relation between fixed ammonium and the other forms of soil nitrogen. Fixed ammonium may be released to exchangeable form (defixation). Exchangeable ammonium is converted to readily available nitrate (nitrification), or used by microorganisms to form humus (immobilization). On the other hand, some of the ammonium produced through decay of humus (ammonification) is fixed by clay minerals. Nitrate nitrogen is also immobilized by microorganisms. (Fig. 5)



Amounts of fixed ammonium nitrogen in some Morrow plot soils. (Fig. 6)

HIGH-OIL HYBRIDS

Make King Corn More Useful

R. W. JUGENHEIMER

A TREMENDOUS BONUS of oil and protein may soon be possible on much of the corn acreage in Illinois. Two newly developed hybrids, Ill. 6021 and Ill. 6052, yield about 25 percent more oil and 10 percent more protein than present commercial hybrids.

If adapted high-oil hybrids were grown throughout the country, the extra oil produced would amount to more than is now received from butterfat, cotton, and flax put together.

Both millers and livestock feeders stand to benefit from high-oil corns. Corn oil is a valuable by-product of the milling industry. It is a nutritious food and also has many industrial uses.

High-oil corn may be more efficient feed for livestock than normal field corn. Oil is high in calories, 1 pound having about 2¼ times the energy value of a pound of starch. In feeding trials at the University of Illinois, market lambs fed the high-oil corn averaged more gain on 6 to 7 percent less feed than lambs fed ordinary corn.

Grain from the new hybrids also contains more high-quality germ protein than do common hybrids. Including this grain in livestock rations will probably reduce the need for expensive protein supplement.

To develop the new hybrids, Illinois agronomists selected open-pollinated varieties that were high in oil and protein but low in yield, and combined them with standard high-yielding inbreds. The new hybrids thus retain the standability, yield potential, and other plant characteristics common to present hybrids, but also contain the new increased amounts of oil and protein. They are adapted in maturity to the southern three-fourths of Illinois.

A limited quantity of double cross seed of the new hybrids is available this winter for testing. Quantity seed production will also get underway this year. **Seed for farm use will not be available until the 1960 growing season.**

R. W. Jugenheimer, Professor of Plant Genetics, is in charge of corn breeding at the University. He is also Assistant Coordinator of the International Cooperation Programs, under which the University of Illinois has contracted with the U. S. government to give technical assistance to India and other countries.

CIP MILK PIPELINES

Cleaned-in-position pipelines of stainless steel, pyrex glass, and flexible plastic prove adapted to dairy barns

M. H. ALEXANDER,
W. O. NELSON, and
E. E. ORMISTON

By 1940, milking and milk handling had become just about as efficient as was possible with the system in use. This consisted of (a) machine milking, (b) manual removal of the milk from the stable, (c) cooling, and (d) storage of milk in cans under refrigeration.

During the late 1940's and early 1950's, permanent milk pipelines, bulk cooling tanks, and bulk milk pick-up were introduced as a means of increasing the efficiency of dairy farm operations. Pipelines had been in limited use before this time. However, many markets required that pipelines be dismantled for cleaning after each use. This requirement offset any savings in labor that might result from the use of pipelines.

The general acceptance of milk pipelines therefore depended on whether they could be satisfactorily cleaned in position. Accordingly, in 1950 the Department of Dairy Science began a series of studies on the use and care of milk pipelines.

E. E. Ormiston, Assistant Professor of Dairy Production, in charge of the University of Illinois dairy herds and farms; M. H. Alexander, Associate Professor of Dairy Husbandry, in charge of AR and HIR testing; W. O. Nelson, Professor of Bacteriology in Dairy Science. From 1952 to 1954 Professor Alexander served as adviser in dairy science at the Allahabad Agricultural Institute, India, under a contract between the University of Illinois and the U. S. government.

The first studies were of stainless steel pipelines. Later pyrex glass pipelines were tried, and the most recent studies have been with flexible plastic pipelines. It was found that any of these systems may be cleaned in position without impairing milk quality.

All the studies were conducted by the authors at the University of Illinois dairy farm during the routine operation of the equipment by farm employees.

Stainless Steel and Glass Pipelines

Milk quality. The first study lasted 6 months. Milk produced in a stanchion barn with cleaned-in-position (CIP) stainless steel pipelines was compared with milk removed manually. Standard bacterial plate counts were made every day on morning and afternoon samples.

Milk produced with the two systems was of equal quality. Plate counts averaged less than 10,000 bacteria per milliliter. Similarly, the quality of milk handled through a pipeline remained the same whether the line was cleaned in place or was disassembled before cleaning.

Despite the generally low bacterial count of milk handled through pipelines, important day-to-day variations were noted in the plate counts. Additional experiments indicated that these variations were associated with the work habits of individuals operating the pipeline. When certain operators used and cleaned the pipeline system, bacteria counts were consistently low. With less careful operators, however, counts were considerably higher.

The CIP stainless steel pipelines were later compared with pipelines made of pyrex glass. Milk quality was not affected by the composition of the pipeline.

Efficiency of operation. Labor (time) requirements for milking operations were measured by standard time and motion study methods. A comparison was made of the time needed for a man to operate (a) two units with a pipeline, (b) four units with a helper to carry the milk, and (c) four units with the helper also preparing the cows. It took 2 minutes to perform the routine steps in milking a cow, including 1 minute for machine-stripping.

Records of the time the machine was on the cow showed major differences. Average times, including machine-stripping, were as follows: two units with the pipeline, 5.0 minutes (range, 3.5 to 7.5); four units with helper carrying the milk, 7.0 minutes (range, 5.0 to 9.1); four units with the helper also preparing the cows, 5.8 minutes (range, 2.9 to 9.2).

These data indicate that when one man operates more than two units, the machine is on a cow longer than is required for good milking. A pipeline makes milking in a stanchion barn an efficient one-man operation. The labor of carrying milk and absences from the cow are eliminated.

Flexible Plastic Pipelines

Studies of flexible plastic pipelines were undertaken with the encouragement and cooperation of the Illinois State Department of Public Health. The quality of milk was determined by routine bacteriological tests and periodic checks on flavor and odor.

Two different commercial dump stations (*see* photographs), each equipped with 100 feet of clear, flexible plastic tubing, were compared with permanently installed stainless steel pipelines. One dump station had a built-in releaser which served in cleaning and sanitizing the tubing. With the other station, the tubing was cleaned and sanitized by connecting it to the automatic cleaning device used with the stainless steel pipeline.

In both barns, the dump station with plastic tubing was alternated with the stainless steel pipeline, each system being used a week at a time. This continued until each installation had been used 6 weeks.

Samples of the evening milk and of the mixed evening and morning milk were taken from the bulk tanks on 5 consecutive days for each week. Each sample was examined by the standard method for bacterial plate count. Thermoduric and psychrophylic plate counts were made once a week. The numbers found were insignificant, indicating that there is no build-up of the heat-resistant or the cold-loving organisms in properly cleaned and sanitized pipelines.

Average total bacterial plate counts are summarized in the table at the right. As can be seen, milk of satisfactory bacteriological quality was produced throughout the entire period in both barns when either stainless steel or plastic pipelines were used.

The high counts at first obtained with the stainless steel pipelines indicated that these lines were not being cleaned and sanitized correctly. The hose cocks were therefore removed and thoroughly cleaned, resulting in reduced plate counts during the later weeks of the experiments. These data stress the importance of carefully cleaning all parts of the milk-handling system.

Bacteria Counts of Milk Carried Through Plastic and Stainless Steel Pipelines

Week	Barn 1 Plastic	Barn 1 Steel	Barn 2 Plastic	Barn 2 Steel
		SPC/ml.[a]		
1	1,400	19,000	2,500	7,800
2	5,500	48,000	4,600	10,000
3	3,200	40,000	3,500	8,300
4	2,300	*5,800	2,600	21,000
5	5,660	6,900	2,000	*2,200
6	6,300	4,500	1,700	1,500

[a] SPC/ml = logarithmic standard plate count per milliliter of milk.
* Hose cocks removed and thoroughly cleaned.

Dump stations used in Barn 1 (left) and Barn 2 (right) for studies of flexible plastic pipelines. The dump station in Barn 2 had a built-in releaser for cleaning the tubing.

Routine for Cleaning Pipelines

The experiments with plastic tubing demonstrate that it can be properly cleaned and sanitized by the routine recommended for stainless steel or glass pipelines and given at the end of this article.

This routine did not harm the plastic tubing. However, when water at 175° F. was used over an extended period of time, the tubing became soft. Sanitizers containing iodine discolored the tubing. The rate of deterioration of the tubing has not been determined.

If a pipeline becomes highly contaminated as the result of improper care, it can be restored to a satisfactory condition with the proper cleaning and sanitizing routine.

The routine used at the University of Illinois is as follows:

1. Immediately after milking, thoroughly rinse the pipeline for 5 minutes with clean water at approximately 90° to 100° F.

2. Wash with a hot (140°-145° F.) synthetic alkaline detergent solution for about 20 minutes. (A synthetic acid detergent is used after each fourth milking.) Detergents are adapted to the hardness of the water. No heat booster is used to maintain the temperature.

3. Sanitize by rinsing for 5 minutes with a 200 parts per million chlorine solution at 90° to 100° F.

4. Immediately before milking, rinse with chlorine solution similar to the one above.

POPCORN . . .

Harvesting and Conditioning For Maximum Popping

W. P. BEMIS

Long before Columbus discovered America, Indians were using popcorn. Explorers in Bat Cave, New Mexico, have found ears of popcorn more than 4,000 years old. Popping popcorn is as old as its cultivation — at least in Peru, where pottery utensils for this purpose have shown up in prehistoric graves.

Prehistoric popped corn was probably only a few times the size of the unpopped kernels. Today, however, popped corn may be 40 times as big as unpopped corn. This advance is due to (1) the development of varieties with the inherent ability to pop well and (2) a knowledge of the factors responsible for popping.

Among these factors is complete development of the kernel size before harvest. This does not necessarily mean, however, that the crop must completely mature in the field. Research at the University of Illinois indicates that under certain circumstances popcorn may be harvested earlier than has been commonly believed.

Harvesting at Proper Maturity

Popcorn was harvested at different moisture contents and then subjected to various treatments to determine the effects on ultimate popping expansion. Some of the corn was frozen before drying to simulate the weathering that takes place if the crop is left in the field until late in the fall.

Four maturity stages. It was found that popcorn can be divided into the following four stages of maturity on the basis of kernel moisture:

Stage	*Percent kernel moisture*
I	50-35
II	35-25
III	25-15
IV	15-10

At Stage I popcorn has not yet reached full kernel development. Throughout this stage, kernel size and popping expansion increase as moisture at harvest decreases (*see* table below). At the end of Stage I the kernels have reached their complete size and their best popping if they are dried in cribs or unheated buildings (*see* graph, page 11).

At Stage II, the cobs, having remained at a constant moisture during Stage I, now begin to dry. Although the kernels have reached full size, they are not mature, for rapid drying of the ears at 110° F. will cause a reduction in popping expansion of 4 to 14 volumes. Forced air drying at 110° is injurious to popcorn which has a kernel moisture over 25 percent. If the ears are frozen at −10° F. for 15 hours before being dried at 110° the popping expansion will be reduced an additional 3 to 8 volumes.

Stage III popcorn can be ear-dried at 110° with only a slight reduction in popping. However, if the popcorn is shelled at 20 percent moisture and then dried at 110°, it dries about twice as fast as the ears, and the popping is reduced by about 5 volumes. If ears with 25 to 20 percent kernel moisture are frozen at −10° for 15 hours before drying, popping expansion may be reduced as much as 4 volumes.

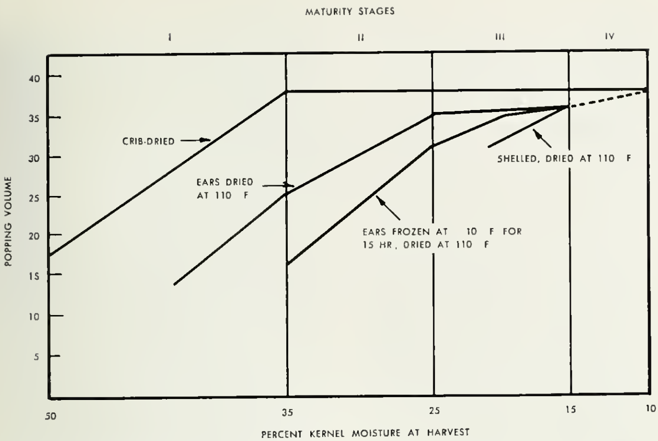
Stage IV is completely mature in that heat drying and freezing of either the ear or the shelled corn do not alter popping expansion. If the popcorn is harvested below 12 to 13 percent moisture, popping expansion will be reduced; but this reduction is not permanent, as popping can be improved by increasing the kernel moisture to about 13 percent.

Percent Moisture, Dry Weight of Kernels, and Popping Expansion After Room Drying of Two Varieties Harvested on Various Dates (Variety A — small kernel; Variety B — large kernel)

Harvest date*	Kernel moisture at harvest		Dry weight per kernel		Popping expansion at 12.5% moisture	
	Var. A	Var. B	Var. A	Var. B	Var. A	Var. B
	percent		*milligrams*		*volumes*	
Aug. 27	49.6	48.3	58	96	14.5	22.5
30	42.5	43.5	72	122	25.5	30.8
Sept. 1	41.2	41.6	82	122	26.5	31.0
3	41.4	41.2	88	132	27.8	34.0
6	36.1	37.6	94	140	33.0	35.0
8	35.9	33.9	93	148	35.0	39.0
10	33.5	32.1	96	146	35.0	38.5
13	30.9	31.4	100	150	36.8	39.2
15	28.9	30.6	103	149	35.2	40.0
17	27.0	28.1	105	154	36.0	38.5
27	18.1	21.3	104	152	34.8	38.2
Oct. 6	17.1	18.0	106	152	35.5	39.2
18	14.0	16.6	104	154	36.5	38.0

* Planted May 25.

W. P. Bemis, Assistant Professor of Vegetable Crops, is a plant breeder developing new varieties of popcorn, sweet corn, and lima beans.



Effects of various treatments on the popping expansion of popcorn harvested at different stages of maturity.

When to harvest. According to the experimental results discussed above, the best time for harvesting popcorn depends on several factors. If adequate, well-ventilated storage is available so that the ears will dry slowly without molding, the popcorn may be hand-picked after 35 percent kernel moisture is reached. For machine harvesting or artificial drying, the popcorn should not be harvested until the moisture is below 25 percent.

For shelling popcorn and drying the shelled corn, the moisture should be below 20 percent — preferably below 15 percent.

A hard freeze may injure the popcorn if kernel moisture is above 20 percent, but a frost will do no damage unless the moisture is above 35 percent.

The condition of the stalks may be a factor in deciding when to harvest. Damage from disease, insects, or weather will increase the danger of loss due to lodging or dropped ears if the corn remains in the field.

Moisture of Shelled Popcorn

The moisture of shelled popcorn is one of the most important factors controlling popping expansion. If popcorn is either too wet or too dry, it will either fail to pop or will pop in an unsatisfactory manner.

Corn will pop when the moisture content is between 8 and 16 percent. For satisfactory popping, however, moisture content must be between 11 and 15 percent, and for optimum popping, it must be about 13 percent. This was true of five different varieties tested.

The moisture content of kernels is controlled by the moisture of the surrounding air. Eight varieties of popcorn were dried to about 7 percent kernel moisture and then placed on trays suspended above water. Corn and water were enclosed in a sealed container and the temperature was kept at 78° F.

In 1 day the moisture content of the kernels increased to about 15 percent; 2 days later it was about 20 percent; and after 8 days it was 28 percent. On the other hand, the moisture content of popcorn kept in a heated room during the winter will decline to about 7 percent, unless it is in a sealed container.

The moisture content of popcorn stored in an outdoor shelter during an Illinois winter will change with the weather conditions, but it is usually around 12 percent — which will give satisfactory popping.

Once shelled popcorn has reached a good popping stage, it should be kept in a sealed container, so that the moisture content will not change. The corn will then stay good for many years.

Test Popping

If you don't know the moisture content of popcorn, you can get an indication by test popping. If the corn pops slowly and not very large, with considerable steam coming from the popper, it is probably too wet and should be allowed to dry further before it is tested again. If the popcorn pops fast with a weak popping sound and is still small, it is probably too dry.

Adding 1 tablespoon of water to 1 quart of popcorn will raise the moisture about 1½ percentage points. If water is added to popcorn, the container should be sealed and turned over or shaken well several times during the first day. It should then be left for several days before any of the corn is popped.

For Good Popcorn at Home

Be sure your popper is hot enough and that the heat is evenly distributed. Popcorn doesn't start to pop until about 350° F.; and popping improves as the temperature is raised to 520°.

A deep skillet or heavy pot gives even distribution of heat. Shaking the popper helps too, as does the use of popping compounds or oils.

The oil should be about one-third the volume of the unpopped corn. Heat the oil in the popper until it first starts to smoke, then add the popcorn. A cup of properly conditioned popcorn will begin to pop in about 85 seconds and finish popping in another minute.

Nylon hotter than cotton?
This question partly answered by studies on

CLOTHING COMFORT

JANE E. WERDEN, M. K. FAHNESTOCK, and RUTH L. GALBRAITH

My husband just won't wear nylon shirts. He says they're too hot in summer and too cold in winter. — I never wear nylon slips in the summer. — This nylon dress looks cool but it's the hottest one I have.

No doubt you've heard a number of comments like these, for many people firmly believe that the newer synthetics, especially nylon, are less comfortable than cotton in hot weather. Research on the comfort of clothing at the University of Illinois, however, has not completely borne out this belief. The Departments of Home Economics and Mechanical Engineering are cooperating in this research, which has been underway for five years.

The work has been done in the Physical Environment unit, a facility of the Graduate College. The main laboratory of this unit is kept at a temperature of 75° F. and a relative humidity of 45 percent. Within the main laboratory is a smaller one, in which the temperature and humidity can be accurately controlled and varied (Figure 1). Thus it has been possible to test clothing under conditions that actually exist in the summer in Illinois.

In this study we were interested in thermal comfort, not total comfort. Thermal comfort is comfort related to temperature and humidity. Total comfort includes thermal comfort plus all other aspects, both psychological and physical.

The work was planned to test two main assumptions: (1) That there is a difference in the thermal comfort of clothing based on fiber content, and (2) that the ability of a fiber to absorb moisture might be one of the reasons for this difference.

Two series of tests have been done on girls between the ages of 19 and 26. These girls have worn complete outfits made from cotton, nylon, acetate, and Arnel fabrics (Figure 2).

During the test periods, each girl wore a thermocouple harness which measured temperature at 20 places on the body (Figure 3). She also sat in a large balance which measured her weight very accurately. Both evaporative and total weight loss were calculated. Evaporative weight loss was the loss that occurred through breathing and evaporation of sweat while a girl was sitting in a balance. It did not include the sweat that had not evaporated. Total weight loss included evaporative weight loss plus all sweat.

Along with these objective measurements, the girls were asked for a subjective comfort vote on a seven-point scale, with 1 rating cold; 4, comfortable; and 7, hot.

The girls were given complete physical examinations before becoming subjects. All tests were run in the afternoon. Diet was not controlled, but the girls were asked to eat about the same amount of food every day at about the same time.

First Series of Tests

The first series of tests was run at temperatures of 70°, 76°, 88°, and 94° F. and at two humidities, 40

Jane Werden, Associate Professor of Home Economics, specializes in textiles and clothing, dividing her time between teaching and research.

The heat and humidity of an Illinois summer were reproduced in this small laboratory within the Physical Environment unit. (Fig. 1)

Outfits of identical style were made up in four different fabrics for the tests on clothing comfort. (Fig. 2)

and 80 percent. The four outfits of clothing were tested on five girls at all eight temperature and humidity combinations. The girls spent 155 minutes in the balance for each test.

We found no differences in thermal comfort resulting from fiber content. The girls gave essentially the same comfort votes for the four fabrics.

Humidity did not greatly affect the comfort votes at the lower temperatures. At the higher temperatures, however, the girls indicated that they felt more discomfort when the humidity was raised from 40 to 80 percent. The discomfort was as great, however, with cotton clothing as with nylon. Regardless of kind of clothing worn, sweat just doesn't evaporate when temperature and humidity are both high.

The comfort vote agreed very well with the skin temperatures taken with the thermocouple harness. No important differences in skin temperature resulted from differences in fiber content.

Evaporative weight loss was not affected by fiber. The greatest loss always occurred at 94° and 80 percent relative humidity. While some large differences in total weight loss did occur, these differences seemed to be more directly related to the weight of the total outfit than to fiber content.

Second Series

Each test of the second series was divided into three consecutive periods, simulating conditions that people actually meet in the summer when they go into and out of air-conditioned rooms.

The first period consisted of one hour in the large laboratory at cool, comfortable conditions (75° temperature and 45 percent relative humidity). At the end of the hour the girl went into the smaller room, which had a temperature of 94° and a humidity of 80 percent. She sat there for 100 minutes (second period). During this time her clothing always became wet with sweat. She then returned to the large laboratory, where she sat in the balance for one hour (third period).

During all three periods the same measurements were taken as in Series I — that is, body temperature at 20 places, total weight loss, evaporative weight loss, and comfort vote. The same clothing was used in this series as in Series I.

Results in the second series followed the same general pattern as in the first series. Again no differences in the comfort votes or body measurements could be attributed to fiber content.

Regardless of type of clothing worn, the girls were comfortable during the first period. This was indicated by their comfort votes as well as by their skin temperatures. During the second period at 94° and 80 percent relative humidity, both comfort votes and skin temperatures showed that the girls were uncomfortable. During the third period the girls were at first slightly chilled, then comfortable again. Weight losses, while different for each period, did not show differences among fibers during any given period.

Why Do People Think Synthetics Are Hot?

While we could find no differences in thermal comfort of the various fibers tested, the popular conception that there is a difference is too strong to be denied at this point.

The fact that there were no differences in thermal comfort does not necessarily mean that there are no differences in total comfort. Also, the differences that are commonly believed to exist among clothing of different fiber content may be more related to the way the fabric is made than to fiber content. Size of yarn, closeness of weave, weight of fabric may make a difference either in thermal or total comfort.

The work on comfort of clothes is continuing, and we are hoping to find some of the reasons why people think synthetics are not comfortable in the summer.

A thermocouple harness measured skin temperatures during test periods. (Fig. 3)

RESEARCH FOR TOMORROW

1959 Farm and Home Festival

W. N. THOMPSON

MARK APRIL 2, 3, and 4 on your calendar as the dates for the second Farm and Home Festival sponsored by the College of Agriculture at Urbana.

Whether you come for one, two, or three days, there will be plenty to see, hear, and do. The packed program includes exhibits and demonstrations, talks on timely topics, and a series of cultural and recreational events.

Why are we having a Farm and Home Festival? First, we know that Illinois residents are interested in what their University and College of Agriculture are doing. Second, those of us on the campus and the county extension staffs want to show and tell the people of the state how we are keeping pace with the times through research and education.

Exhibits

"Research for Tomorrow" is the theme of the festival, with six exhibit areas showing how science serves the farm, the agricultural business, and the home. The six areas will feature:

Research for Tomorrow — in Crops and Soils. These exhibits will show scientific work in progress to improve future production of field, forest, garden, and orchard crops.

Research for Tomorrow — in Livestock. Visit the Stock Pavilion, and you will see many animals from the experimental farms. These animals will be used in demonstrations of the research being done in livestock production.

Research for Tomorrow — in Mechanization. Great progress has been made in mechanizing our farms, but research workers continue to design and perfect machinery and equipment that will do many tasks better and more easily. Results of their work can be seen in this exhibit area.

Research for Tomorrow — in Food Industries. Through these exhibits you'll learn about the dramatic discoveries that research workers are making as they look for better ways of processing food products from the farm and distributing them to the homemaker.

Research for Tomorrow — in Family Living. In beautiful, new Bevier Hall, you will see exhibits and demonstrations of work that makes it possible for all of us to live in better homes, wear better clothes, eat more nutritious food, and enjoy higher levels of living.

Research for Tomorrow — through Education. This exhibit area will show the many educational services offered by the College of Agriculture to students on the campus, to citizens throughout the state, and to people of other states and other lands.

The Speaking Program

Outstanding speakers will cover important subjects of interest to farmers, agricultural businessmen, and homemakers. Four times each day, you will have an opportunity to hear a presentation of one of three topics.

The 15,000 visitors at the 1958 Festival found many attractions in the Stock Pavilion — including animals used in feeding experiments and a "futuranimal" exhibit in a nylon air house.

Art and Talent Shows

The 1959 Town and Country Art Show being held as part of the Festival promises to be the outstanding amateur art show in Illinois. The best works of town and country artists will be selected from district art shows for this state exhibition.

A Town and Country Talent Show will feature performers from various parts of the state, as well as students and faculty.

Youth Day

Young people, with their parents and teachers, are issued a special invitation to attend the Festival on Youth Day, Saturday, April 4. Agriculture Student Guest Day and Home Economics Hospitality Day will be on Saturday, so that high school students can receive information about careers in agriculture and home economics, courses of study in college, and campus life.

Saturday isn't just for the young people, however. As on the other days, there'll be something of interest to everybody.

W. N. Thompson, Associate Professor of Farm Management, is chairman of the committee planning the 1959 Farm and Home Festival.

Recreation

You can enjoy square dancing while you're at the Festival, perhaps picking up a few pointers, and take part in other recreational activities as well.

And on Saturday night, April 4, the students in agriculture and home economics have scheduled their annual "Plowboy Prom" as a finale to the 1959 Festival program. Visiting high school students, parents, alumni, and their friends are invited to share in the Prom, which is the highlight of student social functions on the Agriculture campus.

For Your Convenience

Parking lots will be reserved for Festival visitors in the heart of the Agriculture campus. Special food service facilities will supplement the campus cafeterias and restaurants.

All exhibits, displays, speeches, and food services will be either in University buildings or in temporary greenhouses and air houses, so the weather will be no problem.

Questions, Please?

If you have any questions about the details of the Festival, ask your county farm or home adviser, or write to "Festival," College of Agriculture, Urbana.

A popular exhibit at the 1958 Festival was the display that showed the steps in developing new varieties of mums — work for which the University is widely known. Exhibits at the 1959 Festival will be open from 9 a.m. to 9 p.m. on Thursday and Friday, April 2 and 3, and from 9 a.m. to 5 p.m. on Saturday, April 4.

Students May Become *FORESTERS at Illinois*

J. N. SPAETH

STUDENTS at the University of Illinois may now work for the degree of Bachelor of Science in Forestry, preparing themselves for jobs wherever foresters are needed.

For 20 years the Department of Forestry has offered two years of preforestry training. Until now, students taking this course had to transfer to another state to complete professional training. In June, 1958, however, four-year curriculums in Forest Production and in Wood Technology and Utilization were set up.

Students who completed their preforestry work last June are continuing their studies at Illinois. Junior courses are being offered this year. Next fall senior courses will be offered also. The first degrees will be granted in June, 1960.

The Forest Production curriculum prepares students to manage forest land for a continuous supply of goods and services — that is, for maximum wood production, for watershed protection, for wildlife, for recreational use, or for a combination of these benefits.

The Wood Technology and Utilization curriculum prepares students for work in the wood-using industries. Typical jobs are the development of new and better ways to use wood, the supervision of various steps in the manufacture of a multitude of products from wood, and the purchase and sale of wood and wood products.

Forestry training is broad. It provides a sound foundation in botany, zoology, mathematics, chemistry, and physics, which is necessary for technical training in forestry. It includes humanities and social studies. It also provides a lot of experience in the woods. This includes required summer camp in the Chippewa National Forest in northern Minnesota, a field trip through the South, a study of woodlands near the campus during the school year, and summer employment for pay in the National Forests of the Lake States and the West.

Instruction in forestry subjects is being given by nine staff members, each of whom is a specialist in some phase of forestry. These teachers are also on the staff of the Illinois Agricultural Experiment Station and are doing research on a variety of forest problems.

The new curriculums are offered primarily because many boys graduating from Illinois high schools want to study forestry, and there is a need for trained foresters. Job opportunities exist not only throughout the United States, but also in foreign countries.

J. N. Spaeth came to the University of Illinois in 1938 to organize the Department of Forestry, and has been Head of the Department ever since.

RESEARCH IN BRIEF

Weed Control Chemicals May Damage Susceptible Crops

The chemicals 2,4-D and 2,4,5-T, when carelessly applied for weed control, have severely damaged tomato fields, grape vineyards, shade trees, woody ornamentals, and home gardens in Illinois.

According to surveys conducted over the past 8 years, many sprayer-operators do not realize how far the spray mist can be carried by air currents. It is not uncommon to find damage from 2,4-D ¼ mile from the sprayed area. Damage has even occurred as far away as ½ mile.

Symptoms of injury from 2,4-D and 2,4,5-T are so distinct that they are not easily confused with other kinds of injury or with diseases. In any affected area, practically all the plants will show symptoms, the severity depending on the concentration of the chemical.

After exposure to light concentrations, leaves are distorted, often becoming fan-shaped with crinkled margins. In tomatoes the flowers may drop off and the young fruit become heart-shaped.

When concentrations are heavier, stems and branches become twisted and otherwise deformed. Stems and fruits split open and the entire plant dies.

Results of field surveys have suggested several ways to avoid accidental injury from these chemicals:

1. Do not use high-volatile esters of 2,4-D or 2,4,5-T under any circumstance.

2. Do not use any formulation of these chemicals within ½ mile of susceptible crops if air is moving from the sprayed area toward these crops.

3. Do not use even low-volatile ester or amine formulations of these chemicals in fields immediately adjoining susceptible crops if there is any chance of windshifts while sprays are being applied.

The greatest potential danger arises from using low-gallonage sprayers that apply the weed-killing solution as a fine, concentrated mist. — *M. B. Linn*

The Market for Meats in Hotels and Restaurants

Americans, on the average, eat about one-fourth of their meals outside of homes. Relatively little is known about the kinds and qualities of meats consumed in these meals. The Department of Agricultural Economics is therefore beginning a study of this consumption and of the market management that might influence it. A survey of meat utilization by hotels and restaurants in certain localities is now being made as the first part of this work.

The trend toward increased food consumption outside the home is expected to continue. The facts learned from this study may form a basis for programs to expand meat consumption, or at least for more accurate estimates of the potential market for meats. — *M. B. Kirtley*

Pigs Can Tolerate Zinc in Their Rations

Supplementary zinc in the ration can prevent or cure swine parakeratosis. It is therefore common to add 25 to 50 parts per million of zinc to rations of growing-finishing hogs. Since too much zinc is poisonous, the Department of Animal Science has been conducting experiments to determine whether the amounts commonly fed will cause any trouble.

Ninety-two weanling pigs have been used to determine zinc tolerance and the symptoms of zinc poisoning. Different levels of zinc, ranging up to 8,000 p.p.m. in the diet, were fed for 6 weeks. The zinc was added as zinc carbonate to corn-soybean meal rations.

The maximum level tolerated was 1,000 p.p.m. Higher levels produced symptoms of zinc poisoning. These included a lowered daily gain and a greater feed requirement per pound of gain. Arthritis, hemorrhage in the front flanks, gastritis, enteritis, congestion of the internal organs, and hemorrhages of the brain, lymph nodes, and spleen were also observed. Many animals died within 3 weeks. Hemoglobin values were not affected by the level of zinc fed.

According to this study, growing-finishing pigs can stand at least 20 times as much zinc as they ordinarily get. So, under practical conditions, the occurrence of zinc toxicity from present rations is unlikely. — *D. E. Becker*

Feeding High-Moisture Corn

The new practice of field shelling and mechanical systems of feeding have made it important to learn more about the value of high-moisture corn as feed. Accordingly, a sizable research project on this subject got underway last fall. The project involves three departments of the college: Agricultural Engineering, Animal Science, and Dairy Science.

Corn was combined at about 35, 30, and 25 percent moisture. Field losses were least when moisture was 30 percent. The machine did not work well when the moisture was above 35 percent, but it gave little trouble when the moisture content was 35 percent or lower. Machine loss was less at 25 percent moisture than at 30 percent, but dropped ears made total field loss considerably higher.

The shelled corn was stored in conventional upright silos and is now being fed to swine, sheep, and beef and dairy cattle. Within the next few months many questions should be answered about this new practice of storage and feeding.

Four silo manufacturers in Illinois cooperated through the National Silo Association by supplying silos for this research, and three manufacturers made silo unloaders available on a rental basis. — *E. L. Hansen*

Nimblewill — A "New" Weed

Nimblewill, a native perennial grass, has been found in fence rows throughout Illinois for many years. There was little concern about it in the past, since it did not seem to invade cultivated fields. In localized areas, however, it has recently begun to spread extensively by seed and poses a new weed problem for the farmer. The picture below shows the way it looked in a Lee county cornfield last summer.

Nimblewill does not begin to grow much until late in the spring after the soil has warmed up. As is apparent in the picture, it grows at about the same rate as corn, and thus is difficult to get out of the row.

Delayed spring plowing and planting has helped somewhat in controlling this weed. Growing small grains has helped considerably, because the nimblewill can be destroyed before it produces seed in August and September. A complete control program has not yet been worked out.

Nimblewill represents one of at least 12 closely related species found so far in Illinois. These in turn belong to a large group of grasses known as *Muhlenbergia*, sometimes called Muhly. Most of these species, including nimblewill, have reclining stems that take root at the lower joints. They therefore grow and spread something like a bunch grass. — *R. L. Gantz*

Nimblewill kept up with the corn in a Lee county field this summer.

High Losses Caused by Corn Stalk Rots

Corn stalk rots continue to cause serious losses in Illinois despite substantial progress gained through 50 years of research on their nature and control. As early as 1908, researchers at the University of Illinois became aware of the importance of these diseases and began their investigations.

Subsequent reports have shown that corn stalk rot diseases are caused primarily by the fungi *Diplodia zeae* and *Gibberella zeae*. These organisms gain entrance into the crown and basal stalk tissues during late summer and early fall. Infected plants are killed rapidly, have shredded pith tissues, and frequently break over or lodge.

In 1958, a survey of cornfields in Champaign county revealed that an average of 58 percent of the plants had stalk rot. This figure agrees closely with long-time averages for the state as a whole. In some fields 85 percent of the plants were diseased. Only 5 percent of the plants were lodged in the fields examined. This figure would have been much higher had winds and rains occurred during the harvesting season.

In 170 comparisons of harvested ear weights, ears from stalk-rotted but standing plants weighed 21 percent less than ears from healthy plants. Ears from rotted and lodged plants weighed 28 percent less than ears from healthy plants in the same number of comparisons. When the ears used in these comparisons were shelled and the grain was dried to a uniform moisture content, the grain from rotted but standing plants weighed 18 percent less than the grain from healthy plants; and that from rotted and lodged plants weighed 27 percent less.

On the basis of these comparisons, fields with 58 percent diseased plants suffered approximately a 10 percent loss in yield. Taking into consideration the total corn acreage of the state, the yield loss estimates obtained from the survey, and average market price of corn, stalk rot diseases cause an average annual loss of about 65 million dollars in the state. These losses not only occur to the farmers and seed producers but are passed on to the consumer in the form of higher prices for meat, milk, eggs, and other food products. — *A. L. Hooker and M. P. Britton*

New Pasteurization Method Gives Safe Milk

Heating milk to 187° F. for as little as 0.2 second is as satisfactory as the present public health standard procedure of heating to 143° F. for 30 minutes. This has been determined by tests done in the Department of Food Technology on the ultra high-temperature short-time pasteurization of milk.

New and extremely efficient heat exchangers have made it possible to heat and cool milk and other liquids very rapidly. Since long heating usually harms delicate food flavors and frequently destroys nutrients, short heating times are desirable. However, before a change in the pasteurization procedure could be suggested, convincing evidence was needed that short-time pasteurization is effective.

The proper temperature and time to use were determined by adding heat-resistant organisms to milk and carefully measuring their survival after the milk had been heated to varying temperatures for different lengths of time.

These experiments were undertaken at the request of public health officials, equipment manufacturers, and dairy processors. — *Lloyd D. Witter and Joseph Tobias*

Vertical Mulching Tried in Tight Soils

Will vertical mulching improve the drainage of slowly permeable soils? This problem is being studied in northeastern Illinois by the Department of Agricultural Engineering, University of Illinois, and the Agricultural Research Service, U. S. Department of Agriculture.

Vertical mulching is the insertion of mulch material into the soil profile in vertical trenches. Mulches consist of crop residues, such as corn stalks, straw, or green forage, usually taken directly from the field. A vertical mulching machine makes a narrow slot about 20 inches deep, picks up the mulch material, chops it, and blows it into the trench. The distance between trenches equals the width of the machine's pick-up attachment. This is about 7 feet on the machine being used in this study.

Two different methods of vertical mulching are being used with tile drainage to determine whether the mulch will improve the movement of water through the soil. In one method, vertical mulching is used in conjunction with tile lines, but the trenches are not directly connected with the lines. In the other method, trenches are directly connected with the tile lines by wells filled with corn cobs. For both methods, mulch trenches are placed across the laterals. Farming operations are performed in the usual manner.

Only one year's data have been taken thus far. Further work on the technique of placing the mulch must be completed before results can be evaluated. — *John Replogle*

Management is increasing the yields of this white pine plantation at Sinissippi Forest. The thinning operation shown above was made when the stand was 46 years old. Yields from this and two earlier thinnings totaled 1,150 fence posts and 4,100 board feet of sawlogs to the acre. Four years later the stand contained 23,000 board feet of sawtimber per acre.

Pines Surpass Hardwoods on Upland Soils

Sandy soils too poor for annual crops, pasture, or hardwoods can be profitably used for growing pines. There are about ¼ million acres of such land in northern and central Illinois.

The Department of Forestry has compared the growth of eastern white pine with that of upland, native hardwoods at Sinissippi Forest, Ogle county. In rotations up to 80 years long, pine stands on sandy soils are expected to yield at least twice as much sawtimber as hardwoods on good sites and at least five times as much as hardwoods on poor sites.

Following are growth and yield per acre at age 80 of the highest-yielding hardwood stands on three sites and of a 46-year-old plantation of white pine on sandy soil:

Forest type	*Productivity rating of site*	*Present annual growth, bd. ft.*[a]	*Sawtimber yield, bd. ft.*[a]
Mixed oak.....	Good	235	10,350
White oak.....	Medium	180	7,150
White oak.....	Poor	150	3,950
Eastern white pine........	Medium[b]	925	16,050

[a] International ¼-inch rule.
[b] Poor hardwood site.

The above figures are for unmanaged stands. Management would substantially increase growth and yields. This would be particularly true of pine yields, because pine is more marketable in the smaller sizes than hardwood. Thus, under management, the spread between pine yields and hardwood yields would become even greater.

Pine, in addition to its faster growth and earlier marketability, has another advantage over hardwood: It yields more lumber from a given cubic tree volume. According to Sinissippi Forest utilization practices, total cubic-foot volume of marketable pine trees is converted into board feet of lumber by a factor of 5 to 6.5. A factor of only 3 to 4 is used for hardwood. — *J. J. Jokela and Ralph W. Lorenz*

Can Poultry Use Fat? A New Answer to an Old Problem

Until very recently, all published experimental evidence indicated that poultry, particularly growing chicks, could not tolerate any appreciable amount of fat in the ration. Now, however, this idea is known to be untrue. In fact, it is known that poultry can use fat calories in a highly efficient manner. Why, within just a few years, this contradiction and sudden reversal of thinking?

The manner of substituting fat for the carbohydrate (corn or other cereal grain) of the ration holds the key to the problem, according to research by the Department of Animal Science.

If the substitution is made on a pound-for-pound basis, the results are likely to be disastrous. Growth will be poor, and if the level of fat is great enough, the growing chick or laying hen may be almost devoid of feathers. This explains why the concept developed that fat is not compatible with the well-being of the animal.

If, however, fat is substituted for the carbohydrate on a calorie-for-calorie basis (approximately 1 part of fat for 2 parts of corn), it is highly beneficial rather than detrimental. Growth and egg production are improved and the protein and other nutrients in the ration are used more efficiently.

These divergent results can be explained by the way the two methods of substitution influence the voluntary consumption of feed. Obviously the pound-for-pound method increases the energy content of the ration. Since poultry and many other animals, including man, appear to eat to satisfy the need for energy, fewer pounds of the fat-containing ration are consumed. Thus protein intake is reduced below the amount required for normal development and the deficiency symptoms are in reality those of inadequate protein.

When fat is substituted for carbohydrates on an equal caloric basis, total food intake is not changed, and both energy and protein requirements are met.

Thus the two points of view can be reconciled and the apparent contradiction explained. — *H. M. Scott*

Cuttings Won't Root? Is the Day Length Right?

Evergreen cuttings taken in fall, winter, and spring root much faster and develop more vigorous root systems under an 8-hour day than under a 16-hour day. This is true even of species not usually considered responsive to day length.

Experiments by the Department of Horticulture involved thousands of cuttings, including several varieties of yews and junipers, as well as a number of broad-leaved evergreens. Day length was manipulated by cutting out illumination with black cloth to shorten the day; or by using supplemental light to lengthen the day.

Similar studies will be conducted on deciduous and herbaceous materials and on evergreen cuttings taken during the summer. — *J. R. Kamp*

Piatt Farmers Gauge Effects of Social Security

For four years now, farm operators have been included in the federal social security program. Last spring the Department of Agricultural Economics conducted a survey to learn how farmers have reacted to this program. We asked all landowners and farm operators in one area about their own participation and also about possible effects of the program on farming in their area.

Answers were received from 92 tenants, 35 part owners, 21 full owners, and 59 nonoperating owners. Ages in the four groups averaged 43, 50, 61, and 68 years. These 207 people farmed or owned land in Blue Ridge Township, centering in Mansfield, Piatt county.

Although a majority believed that farmers would retire earlier, fewer than half believed that this would result in an earlier start for young farmers. Some of the land made available through retirement is expected to be annexed to other farms, and farms in general are growing larger.

Slightly more than half of those surveyed believed that the social security program would make it harder for young farmers to accumulate cash and retire debts. Very young farmers and small-scale operators felt that payment of contributions was a hardship.

Most of the people interviewed predicted that landlords would not use benefit payments to improve their farms. The program has resulted in very few lease changes.

Farmers in this area as in others have long prepared for retirement by putting savings into the purchase of land. There is little evidence that social security is changing this. A small majority of those interviewed, however, expect that farmers will carry less life insurance.

A mimeographed report (AERR 26), "Consequences of Farmer Participation in the Social Security Program," summarizes the Piatt county study. It may be obtained by writing to the Department of Agricultural Economics, University of Illinois, Urbana. — *C. L. Stewart, F. J. Reiss, and L. C. McKinney.*

New Procedures Improve Tree Budding Results

If you have had poor luck in budding to improve the variety of a fruit, pecan, or walnut tree, two additions to the standard procedures may give a better take.

Both the budwood and an area of the stock branch may be wiped with a cloth dipped in a 20-percent mixture of ferbam fungicide (wettable powder) in water. First suggested by A. M. Gorenz of the U.S. Department of Agriculture for the budding of tropical rubber trees, this procedure was tried with good success in 1958 on eight species of fruit and nut trees at the Illinois Agricultural Experiment Station.

Covering buds and the surrounding trunk with a wrap of polyethylene plastic film was another method for improving the take of pecan, walnut, and persimmon buds.

The quickest and most uniform union of walnut buds to the stock trees occurred when the ferbam treatment was combined with a cover of black polyethylene. This cover was left on the budded area for about 3 weeks.

These methods are discussed more fully in the leaflet, "Fruit Growing No. 13," which may be obtained by writing to the Department of Horticulture, University of Illinois, Urbana. — *J. C. McDaniel*

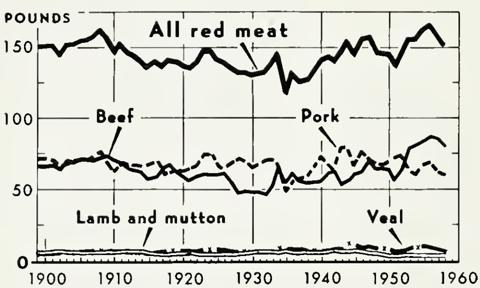
FARM BUSINESS TRENDS

Farm Income. Most farmers had a good year in 1958. Net realized cash income from agriculture was about one-fifth greater than in the year before. The increase occurred largely because of weather conditions.

Good feed supplies started ranchers and farmers to holding back cattle. The resulting cut in meat output raised the prices of meat animals and increased the returns from livestock. Record crops, together with price support, added further to farm income. Crop production was 11 percent higher than the previous record, which was set in 1948 and equaled in 1956 and 1957.

These income-lifting forces are not likely to be repeated in 1959, so a moderate decline in income can be expected.

Consumer Demand. Employment, wage rates, and consumer incomes are slightly higher than they were last winter, but about 7 percent of the labor force is still unemployed. The major factor holding back complete recovery is a low level of business spending for new plants and equipment.



Changes in meat consumption during the past 60 years. The sharp decline in 1957 and 1958 occurred when farmers cut their marketings of hogs and cattle. More hogs, and possibly more cattle, will be marketed in 1959.

Beef Cattle. Cattle numbers increased about 4 percent in 1958, beef output shrank 6 percent, and cattle prices went up 15 percent. A further increase in numbers is likely this year, but some cattle that were held back earlier will be slaughtered. A small increase in beef output, combined with larger supplies of competing meats, may bring about lower prices for cattle in 1959.

Hogs. The pork supply shrank from 67 pounds per person in 1956 to 60 pounds in 1958. It will probably swell to about 67 pounds again in 1959. Prices of hogs are expected to average about one-fifth lower in 1959 than in 1958.

Dairy. Consumption of dairy products is slowly catching up with production. Purchases of butter and cheese for price support represented 9 percent of all milkfat produced in 1953, but only 3 percent in 1958. Commercial utilization of dairy products will be nearly equal to total production in 1959.

Corn. The total supply of corn for the 1958-59 marketing year is about 5,267 million bushels, 9 percent more than for last year. The price of corn rose quickly after harvest, about equaling the lower price support level of $1.06 a bushel. Further rise is possible, but most deficit areas are much better supplied with feeds than they were a year ago.

Soybeans. The soybean supply for this year is about 595 million bushels, 20 percent more than a year ago. Increasing production of poultry and hogs provides a strong demand for soybean meal. Demand for oil is fair. Processing margins have been favorable, encouraging a large crush of beans. Prices will probably about reach support level by late spring.

Fact for thought. Advances in production methods in agriculture, as in other industries, must be matched by suitable changes in financing, management, and scale of operations. — *L. H. Simerl, Professor of Agricultural Economics*

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To:

Spring, 1959

ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

IN THIS ISSUE

Beef calves on an all-roughage ration eat more, and convert the feed to gain more efficiently, when the hay is pelleted (page 3).

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ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

CONTENTS

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Louis B. Howard . . . . Dean and Director
Tom S. Hamilton . . . . Associate Director
Adrian Janes . . . . Station Editor
Margery E. Suhre . . Editor, ILLINOIS RESEARCH

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THE ILLINOIS AGRICULTURAL EXPERIMENT STATION

is responsible for all agricultural research done or sponsored by the University of Illinois. The responsibility is a serious one. Illinois ranks third among the states in total value of agricultural products, and her continuing prosperity depends on maintaining a sound and profitable agricultural economy. The Experiment Station must therefore provide continuing information on better ways to produce, preserve, process, and market foods, fiber, and other materials. At the same time our soil, water, and other food-producing resources must be conserved to the utmost.

The Illinois Agricultural Experiment Station was established in 1888. Agricultural research, however, had already been initiated at the University of Illinois (then the Illinois Industrial University). In 1876 Professor George Morrow started the now world-famous Morrow soil plots, and Professor T. J. Burrill was proving for the first time that certain fruit blights are caused by bacteria.

In 1958 over 400 academic and nearly as many non-academic staff members in 13 research departments worked on 348 research projects. Agricultural research is now being conducted on 1,927 acres of land in Champaign county and on 8,420 acres in 25 other counties.

During the early years, our research was mostly concerned with better and more economical methods of producing agricultural products. Today, however, while this type of research is continuing, much of our attention is directed toward basic research, and toward more efficient methods of processing and marketing.

Our hope is that, through ILLINOIS RESEARCH, you will receive prompt news of research which may be of interest and value to you.

— *Tom S. Hamilton, Associate Director*

Born at Paris, Illinois, Dr. Hamilton received his education at the University of Illinois and has been on the staff of the University since 1920. Until 1954, when he became Associate Director of the Experiment Station, he taught and conducted research in the Division of Animal Nutrition.

PELLETS for PROFIT in Feeding Beef Calves

A. L. NEUMANN, R. J. WEBB, and G. F. CMARIK

PELLETING HAY, or compressing it into small, high-density particles, offers many possibilities for the cattle feeder. Some of the advantages, such as the following, are obvious:

1. Pellets are ideally suited to mechanical feeding or self-feeding.

2. Storage space requirements are reduced by about three-fourths.

3. Wastage of the leaves, which are the most valuable part of the plant, is greatly reduced.

4. Cattle cannot sort out the more palatable portion of the hay.

5. Hay pellets can be more easily and more accurately mixed with the concentrate portion of the ration.

This list alone makes a good case for pelleting hay. However, the possibility of other important advantages was suggested to us by previous work at Illinois and elsewhere with pellets containing all the components of a cattle ration. As a result, we recently conducted two experiments with pelleted hay at the Dixon Springs Experiment Station, which is located near Robbs, in southern Illinois.

Alfalfa-Timothy Used in Trial 1

Thirty 425-pound steers were placed in three lots and fed either long (baled), chopped, or pelleted hay according to appetite for 119 days. All calves had access to salt and a complete mineral mix.

The hay was a mixture of about two-thirds timothy and one-third alfalfa, all cut and baled at the same time from the same field. It was considered average in quality as far as stage of maturity, color, leaf content, and freedom from foreign matter were concerned. Just before the test, some of the hay was chopped into 4- to 6-inch lengths with a forage chopper. Another portion was finely ground with a hammermill and pelleted by extruding it through a 3/16-inch die.

From the start of the test it was obvious that the calves preferred the pellets to the long or chopped hay. As shown in the chart on the next page, calves fed pelleted hay ate about one-third more hay during the test than did the calves on long or chopped hay.

This great increase in feed consumption resulted in a dramatically improved performance. Daily gains were nearly tripled, and costs of gain were reduced by about $4 a hundred-weight. Each ton of pelleted hay produced about 100 pounds more gain than the long or chopped hay.

Effect of Hay Quality

The purpose of a second experiment was to find out whether quality, as determined by kind of hay, affected response to pelleting. A high-quality hay (alfalfa) and a low-quality hay (sericea lespedeza) were tested.

Again 425-pound steers were fed, this time for 112 days. Two lots were fed on straight alfalfa, with one lot receiving 3/16-inch pellets and the other lot, long hay. Similarly, another two lots were fed pelleted and long sericea lespedeza. A check lot on timothy-alfalfa pellets was included in the tests. Again all calves were fed according to appetite, and mineral and salt were available.

As shown in the table (page 4), the apparent effects of pelleting alfalfa were similar to the results obtained with timothy-alfalfa pellets in the first trial. Daily feed consumption per calf was increased from 11.3 to 16.5 pounds, or by about one-half. In the sericea lots, however, feed consumption was increased only slightly.

When feed consumption was expressed as feed consumed per 100 pounds of body weight, pelleting resulted in 23 and 7 percent more feed intake for alfalfa and lespedeza, respectively. This is perhaps a more accurate measure of the effect of pelleting on feed intake than is average daily consumption. Naturally calves which gain faster are becoming increasingly larger as a test continues.

The sericea lespedeza used in these experiments was extremely fibrous and coarse. This may account for some of the difference in response.

Why the Improved Performance?

Cattle seldom gain well on all-roughage rations fed as long hay. The supply of available nutrients is

A. L. Neumann, Professor of Animal Science, specializes in the feeding and management of beef cattle. He does teaching and research at Urbana. Co-authors Webb and Cmarik do research at the Dixon Springs Experiment Station in southern Illinois.

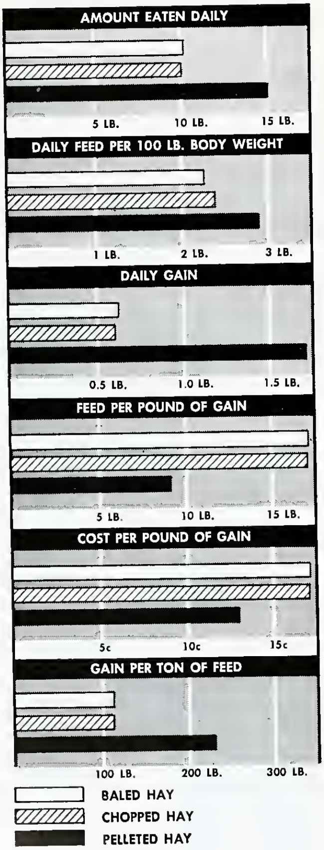
limited by the amount of roughage that an animal can eat during a day, and this supply little more than meets the maintenance needs of the animal. Young animals, especially, have difficulty because, in relation to their body weight, they have rather a limited capacity for bulky roughages such as hay.

When animals consume an extra amount of hay as the result of pelleting, the energy supplied by a ration may be increased almost as much as when a concentrate, such as corn, is added. Pelleting of hay probably does not increase the animal's capacity for roughage, at least not greatly. The increased intake is probably due to a more rapid passage rate from the rumen or paunch. Studies at other stations have shown that ground hay remains in the paunch a shorter time than long hay.

In our studies it was observed that calves on pellets seldom ruminated — that is, chewed cuds. The fact that they spent less muscular energy in rumination may account for some of the improved feed conversion. The energy furnished by the electric motor which drove the machinery for the pelleting process was probably cheaper than the energy from feed that steers used in ruminating long hay.

It should be mentioned that simply chopping the roughage without pelleting, as was done for one of the lots in Trial 1, increased neither feed intake nor gains; nor did it alter feed conversion. The favorable results thus cannot be attributed to grinding or chopping alone. In fact, earlier work at Illinois has shown that fine chopping reduces digestibility of roughages by ruminants. This is probably because the fine particles leave the paunch before they are fermented by bacteria, or perhaps because some of them bypass the paunch completely.

Perhaps the pelleting process insures that the feed goes into the paunch and also makes possible the bacterial breakdown of crude fiber in short order — this without the usual rumination process.



Pelleting timothy-alfalfa hay greatly increased feed consumption, daily gain, and feed conversion. It also decreased the cost of a pound of gain, even though processing the pelleted hay added $10 a ton to feed cost. Hay that had been chopped, but not pelleted, did not offer any advantages over baled hay.

Five More Advantages Brought Out in Experiments

Results of the two trials at Dixon Springs lead us to conclude that pelleted hay has the following advantages for calves, in addition to those mentioned earlier:

1. Pelleting increases feed intake up to 35 or 40 percent.

2. The extent of the increased intake is associated with the quality or type of hay fed.

3. Pelleting hay doubles or even triples rate of gain.

4. Pelleting greatly improves conversion rates of all-roughage rations.

5. Costs of gain on roughage alone are reduced by pelleting, even when it costs $10 a ton to process the pellets.

Work in Progress

Further trials are now being made, both with pelleted hay alone and with complete pelleted rations, to evaluate more fully this rather new approach to feed harvesting, storage, and feeding.

Results to date have been so favorable that we believe there is no question as to the nutritional value of pelleted hay. Apparently the only factor limiting its use on livestock farms is the lack of machinery. Manufacturers are now busily engaged in perfecting portable machinery which they hope can be economically used to pellet hay from the windrow.

How Pelleting Different Kinds of Hay Affected Performance of Beef Calves Fed Only Roughage for 112 Days

Item	Alfalfa		Sericea lespedeza		Alfalfa-timothy, pelleted
	Baled	Pelleted	Baled	Pelleted	
Number of calves	10	10	10	10	10
Av. initial weight, lb	422	426	425	425	425
Av. daily gain, lb	0.18	1.77	0.18	0.38	1.33
Daily feed per head, lb	11.3	16.5	12.1	13.4	15.0
Daily feed per cwt., lb	2.6	3.2	2.8	3.0	3.0
Feed per lb. gain, lb	63.0	9.3	59.0	38.0	11.3
Cost per lb. gain, cents	62.0	13.9	42.6	48.7	15.9
Gain per ton dry matter, lb	39	253	42	75	206

50 Years of Progress in LAMB FEEDING

U. S. GARRIGUS, E. E. HATFIELD, H. W. NORTON, and R. K. MOHRMAN

Many improvements in lamb feeding have resulted in more and better meat and wool at a lower cost per unit.

Major Developments

Self-feeding has gained acceptance in farm feedlots only relatively recently, although commercial feeders have used this method for many years. Significant advantages of self-feeding as compared to hand-feeding are:

Lower labor requirements. Filling a self-feeder every few days is certainly not as exacting nor as time consuming as is punctual, twice-daily hand-feeding.

Greater uniformity. With feed continuously available, each lamb will eat its fill and adjust its own feed intake. When lambs are hand-fed, the less aggressive ones usually do not get a proportionate share and the group finishes unevenly.

Shorter feeding period. Because lambs are full-fed from the start, they reach market finish in less time.

The lamb on the scale, self-fed a complete pelleted ration, gained at the rate of 0.88 pound a day, while the other lamb, hand-fed alfalfa hay and shelled corn, gained at the more common rate of 0.25 pound. Both were part of an exhibit prepared by the University of Illinois, at the request of the American Society of Animal Production, for the 1958 International Livestock Exposition. Theme of the exhibit was "50 Years of Progress in Animal Science."

Complete, mixed rations usually give better results than a free-choice system of feeding. Not only does the complete ration increase rate of gain, but it also reduces death losses due to "overeating disease" (enterotoxemia). The trend to complete, mixed rations continues as machinery for feed preparation is improved and knowledge of lamb nutrition is increased.

Antibiotics in a fattening ration have given variable results, depending upon type and level of antibiotic used, health of the lambs, and type of ration. Initial experiments with ruminants did not produce desirable results. However, low levels (about 7.5 milligrams) of chlortetracycline or oxytetracycline did increase rate of gain for feedlot and creep-fed lambs in experiments at the Illinois Agricultural Experiment Station in 1952. Concurrently, death losses from enterotoxemia were sometimes reduced.

Pelleting of the entire ration usually increases feed consumption and rate of gain, and reduces feed required per unit of gain. Improved performance from pelleted hay was reported by the New Mexico Agricultural Experiment Station in 1953. That same year the Illinois Station obtained good results with a complete pelleted ration.

In addition to improved performance, pelleted rations offer these advantages:

Reduced ration cost. Pelleting permits the use of a lower grade roughage and a higher level of roughage.

Ease of handling. Pelleted feed is less dusty, requires less storage space, and is more easily self-fed.

The major disadvantage at present is the cost of pelleting. Improved machinery should reduce this.

Experimental Developments

New high-oil, high-protein hybrid corns (see Illinois Research, Winter, 1959, p. 7) have been used in lamb feeding studies since 1953. Average results from all trials have been a 7-percent increase in rate of gain and a 6-percent reduction in feed required per unit of gain. Use of the new hybrids by feeders will probably depend on whether these hybrids yield as well as others.

Estrogenic implants, in comparison with other treatments used, have consistently given the greatest increases in rate of gain and the greatest reduction in feed required per unit of gain. Wether lambs, implanted with 3 milligrams of diethyl stilbestrol, made approximately 25 percent greater gain than lambs not implanted. There was also a reduction of about 25 percent in feed required per unit of gain. Ewe lambs would be expected to give a somewhat lower response.

Some problems remain to be overcome in estrogenic implanting of lambs. Pelts are more difficult to remove and the incidence of urinary calculi seems to be increased. The treatment has not yet been approved by the Pure Food and Drug Administration for commercial use in lambs. Approval of some estrogenic implant can reasonably be expected since a comparable treatment has been approved for beef cattle.

Carcass evaluation studies are being made to correlate consumer acceptance with feedlot performance in all the experiments reported here.

Much progress has been made in lamb feeding. Much more progress is possible.

The authors are all members of the Department of Animal Science.

The Way to a Man's Heart — Through His Stomach?

Research on diet and heart disease points up the value of a well-balanced diet

PATRICIA V. JOHNSTON

WORRY OVER HEART DISEASE has made many Americans diet-conscious. Unfortunately, of the diets that have been proposed to prevent heart disease, most have emphasized the role of a single food or kind of food. They have tended to ignore the complex interrelationships that exist between the three major components of food — fat, protein, and carbohydrate.

Many of the suggested diets are "freak" diets, far removed from a normal, palatable, well-balanced diet. For instance, in some of these diets as much as one-third of the caloric intake is furnished by a vegetable oil.

Research in the Department of Food Technology indicates that there is little evidence to favor the radical changes in diet that have been suggested.

Atherosclerosis Receives Study

In the Department of Food Technology, work on heart disease has been concentrated on atherosclerosis. This is the most commonly occurring disease of the arteries, especially of the coronary arteries. In the early stages of the disease, fats and related compounds (lipids) are deposited in the inner lining or intima of the arteries. In the later stages, fibrous tissue develops, and calcium is deposited, as well as increasing amounts of lipid. As the disease advances, it involves not only the inner lining of the arteries, but also the layers of tissue beneath the intima.

Many investigators believe that atherosclerosis is caused by disturbances of the metabolism of the lipids, particularly cholesterol and lipoproteins (combinations of lipid and protein). This theory has been based on numerous observations which have shown atherosclerosis to be associated with high levels of cholesterol and other lipids in the blood serum.

Disorders of metabolism can be caused by a variety of factors, one of them diet. Since it is relatively easy to control diet, a great deal of the research on atherosclerosis has been directed toward the role of diet in the development of the disease.

Patricia V. Johnston, Research Assistant in Food Technology, with F. A. Kummerow, Professor of Food Chemistry, who is directing the work on diet and heart disease in the Department of Food Technology. They are in the laboratory where much of the basic research is done. The work has been made possible by grants from the National Institutes of Health, Illinois Heart Association, American Dairy Association, Pure Milk Association, National Livestock and Meat Board, Kretschmer Corporation, and Armour and Company.

Two Phases to Work

The research program on atherosclerosis in the Department of Food Technology has been divided into two main phases.

The first phase is concentrated entirely on nutrition. The effect of various dietary compounds on the serum cholesterol levels and the incidence of atherosclerosis in laboratory animals is being studied.

The nutritional research program is being supplemented by basic research on (a) the metabolism of cholesterol, other lipids, and lipoproteins, and (b) the factors which alter this metabolism.

Protein Intake Important

Both the nutritional and the basic research have shown that the amount of protein in the diet has an important effect on cholesterol metabolism.

Abnormal amounts of lipid were found in the blood serum of chickens only when they received a diet low in protein. As a result of this discovery, the "E/P ratio" was introduced. This is the ratio between the energy value of the diet and the protein intake. To calculate the E/P ratio of a food item or diet, the num-

ber of available calories in 100 grams is divided by the protein content. A high E/P ratio would mean a high proportion of fat and carbohydrate; a low E/P ratio would mean a low proportion of these substances.

When the E/P ratio of a diet was high and the diet contained "soft" fats (vegetable fats), the serum cholesterol levels were found to be within the normal range. However, when the diet contained animal fat and the E/P ratio was high, the serum cholesterol levels were above normal. When the E/P ratio was low, serum cholesterol levels were within the normal range regardless of the type of dietary fat.

Thus it appears that "soft" fats help to keep the blood cholesterol levels down only when the ratio of energy to protein is high. Even then, if excess calories are not "burned up" by muscular activity, they may increase the synthesis of lipids, and hence build up the lipid levels in the blood serum.

Well-Balanced Diet Recommended

It is not suggested that caloric intake should be reduced below minimum levels or that violent exercise should be taken to "burn up" excess calories. It is suggested, however, that the most sensible course is to maintain a well-balanced diet. Only when the serum cholesterol level is extremely high should the diet be drastically altered — and this must be done under the supervision of a physician.

Although the average person generally believes he does consume a well-balanced diet, he might be surprised if he rigidly analyzed his diet for one week. It is easy to forget the odd snacks of high-calorie foods and the missed lunches because one was "too busy to bother." A diet should be consistently well-balanced if it is to be of maximum value to good health. Eating well over the week end does not make up for lunching on a doughnut and coffee during the week.

Tables 1 and 2 are presented as aids in planning a well-balanced diet. The daily caloric intakes and minimum protein requirements in Table 1 are for people who engage in a moderate amount of physical activity. Very active people would need more calories; inactive people, fewer.

A. Ueno, on leave of absence from Nagasaki University, Japan; and T. Nishida, also from Japan, work with Dr. Johnston in preparing bile for analysis. A native of England, Dr. Johnston received her Ph.D. from the University of Illinois in 1957.

Suggestions for a day's meals are outlined in Table 2. These meals provide more protein (89 to 107 grams) than the minimum amounts given in Table 1. It is not advisable, however, to increase the protein intake of most individuals much beyond 100 grams a day. Excess protein can, by chemical changes in the body, result in increased fat.

The calories provided by the diet in Table 2 are below the intakes required by some individuals. It is very easy, however, to increase the number of calories in the diet — for example, simply by adding a piece of pie.

It is emphasized that we are not recommending a diet for clinical use in lowering a high serum cholesterol level. Rather, we are calling attention to the importance of a consistently well-balanced diet as a possible preventive measure against heart disease and as a most important contribution to general good health.

Table 1. — Recommended Daily Caloric Intakes and Minimum Protein Requirements[a]

Age (yr.)	Weight (lb.)	Height (in.)	Calories	Protein (gm.)
		MEN		
25.....	154	70	3,200	70
45.....	154	70	3,000	70
65.....	154	70	2,550	70
		WOMEN		
25.....	128	65	2,300	58
45.....	128	65	2,200	58
65.....	128	65	1,800	58

[a] As proposed by the Food and Nutrition Board, National Research Council, 1958.

Table 2. — Suggestions for a Balanced Diet for One Day[a]

Food item	Protein (gm.)	Fat (gm.)	Carbohydrate (gm.)
BREAKFAST			
4 oz. orange juice	....	....	15
½ cup cooked or dry cereal......	2	....	15
1-2 scrambled eggs	7-14	5-10	.....
1-3 slices bread....	2-6	....	15-45
1-2 pats butter.....	....	5-10	.....
8 oz. whole milk....	8	10	12
Coffee or tea......	....	....	.....
1 teaspoon sugar...	....	....	7
Totals......	19-30	20-30	64-90
LUNCH			
2 sandwiches made of:			
4 slices bread..	8	....	60
2 pats butter...	....	10	.....
3 oz. lean meat or cheese....	21	15	.....
Canned or fresh fruit (2 peach halves).	....	....	15
8 oz. whole milk....	8	10	12
Totals......	37	35	87
DINNER			
Fruit or vegetable salad..........	2	....	20
3-4 oz. lean meat or fish............	21-28	15-20	.....
½ cup cooked vegetable..........	2	....	10
1 medium size baked, boiled, or mashed potato.........	2	....	15
1 slice bread......	2	....	15
2 pats butter......	....	10	.....
1 serving ice cream	4	12	21
Coffee or tea.....	....	....	.....
1 teaspoon sugar...	....	....	7
Totals......	33-40	37-42	88

[a] This diet furnishes 89 to 107 grams of protein and 2,140 to 2,557 calories a day. The energy-to-protein (E/P) ratio is low — approximately 23.0.

CONCENTRATED MILK
May Find Wide Market

R. W. BARTLETT

A PRODUCT which may mean great changes in the dairy industry has resulted from many years of experimentation, including pioneer work at the University of Illinois. This product is concentrated milk. There are two kinds — fresh and sterile.

Fresh concentrated milk is usually Grade A whole milk which has been reduced to a third of its original bulk by the removal of water. It must be kept under refrigeration. It is usually marketed in quart or third-quart paper containers.

Sterile concentrated milk is a high-quality milk from which about the same amount of water has been removed as from fresh concentrate. Like evaporated milk, it may be packaged in tins and held at room temperatures for at least 2 months. While sterile concentrate is not yet on the market, at least three plants for processing it are being built, and it should be available commercially sometime this year.

Concentrated milk differs from evaporated milk in that more water is removed from the concentrate.

Concentrates Pass Taste Tests

The high quality of fresh concentrate has been shown by many taste tests conducted at the University of Illinois during the last 7 years. Recently a sterile concentrate developed by Dr. E. O. Herreid of the Division of Dairy Technology has also been tested. This product has been stored in tins and held for 2 months at 70° F. When reconstituted it tastes so much like fresh whole milk that many people cannot tell the difference.

One branch of the military service, after many experiments, has pronounced sterile concentrate acceptable for use as a beverage after being held under refrigeration for 90 days or in frozen form for 180 days.

R. W. Bartlett, Professor of Agricultural Economics, has made special studies of store sales versus home deliveries of milk, federal regulation of milk prices, paper milk containers, and the school milk program, as well as of concentrated milk.

Can Concentrated Milk Compete Commercially With Whole Milk?

Eight years ago a flurry of excitement greeted the appearance of fresh concentrated milk on many markets. At most places, the concentrate did not compete successfully with whole milk. It did, however, succeed in California and Iowa.

In the San Francisco area, for example, concentrated milk has been available to consumers since June, 1951. Sales of fresh concentrate accounted for 20 percent of total milk sales in specific stores by the end of 1952. In 1958 the figure had risen to 31 percent.

Analysis of the reasons for this success shows that it can be duplicated elsewhere. These reasons are:

High quality. University of Illinois taste tests have shown conclusively that consumers cannot tell the difference between fresh whole milk and the California concentrate when reconstituted.

Low price. When the concentrate was first introduced in San Francisco, it cost 3 cents a quart less than fresh whole milk. By March, 1957, the difference was 5 cents.

Advertising. Frequent newspaper advertisements remind consumers that concentrated milk combines high quality with low prices.

Convenience. Getting the equivalent of 3 quarts of milk in a 1-quart container not only makes shopping easier but also saves storage space.

How Much Cheaper Is Concentrated Than Whole Milk?

Price differences between whole milk and evaporated milk in various parts of the country are shown in the table at the top of page 9.

Sterile concentrated milk can be processed and sold for about 1 cent a quart more than evaporated milk, including ½ cent for extra costs of concentration and ½ cent for extra quality. This would mean that the sterile concentrate could be sold for 7.7 cents a quart less than whole milk in the South; 7.1 cents in the Northeast; 5.4 cents in the West; and 1.7 cents in the Midwest.

Fresh concentrated milk processed in the Midwest can be sold within a 1,000-mile radius for about 2.5 cents a quart more than evaporated milk. Included in the extra cost would be the following items:

2.15 cents — Difference between Class I price (Chicago) and condensery price
0.50 cent — Extra cost of concentrating on a 3-to-1 basis
0.23 cent — One-third of the difference between gross distributor spread in 1958 for whole milk (10.6 cents) and evaporated milk (9.9 cents)
0.65 cent — Extra cost of transportation

From the total of 3.53 cents would be subtracted 1 cent, which represents the saving in packaging. Thus, the net increase would be 2.5 cents.

From these figures, we see that fresh concentrated milk processed in the Midwest can be shipped as far as 1,000 miles and sold at 6.2 cents a quart less than whole milk in the South; 5.6 cents less in the Northeast; and 3.9 cents less in the West. In the Midwest, fresh concentrate would sell for about the same price as fresh whole milk.

The figures in the table do not show the full variation in milk

What Consumers Paid for Whole and Evaporated Milk in Different Regions[a]

Region	Whole milk, price per quart 1958	Evaporated milk, price per quart of milk equivalent 1958	Amount by which price of fresh milk exceeded price of evaporated milk				
			1958	1949	1939	1929	1919
			Cents per quart				
South	24.9	16.2	8.7	7.96	5.09	3.57	1.69
Northeast	24.3	16.2	8.1	6.43	4.45	3.35	−1.02
West	22.7	16.3	6.4	4.92	2.91	2.00	−1.66
Midwest	19.2	16.5	2.7	3.04	2.56	1.44	−2.07
United States	22.8	16.3	6.5	5.73	3.90	2.69	−0.54

[a] The 50 markets used in this study were those for which retail price data for evaporated milk were reported by the U. S. Bureau of Labor Statistics. Prices of whole milk are from the U. S. Department of Agriculture Fluid Milk and Cream Reports.

prices. As shown in the chart, whole milk in Jacksonville, Florida, cost 12.7 cents a quart more than evaporated milk. The average difference between whole and evaporated milk was 11.0 cents in the 10 cities with highest prices for whole milk. This difference was only 1.5 cents in the 10 lowest-priced cities.

These figures indicate that there is a large potential demand for concentrated milk in the high-priced and medium-priced markets, but that the potential demand in the low-priced markets is negligible. In addition to the domestic demand, it is probable that foreign markets will eventually use substantial quantities of concentrated milk.

Will Lower Prices Affect Demand?

Assuming that in many markets concentrated milk can be sold for substantially less than whole milk, will the lower prices increase consumption of milk? The answer to this partly depends on the elasticity of demand for whole milk.

Early studies have indicated that the demand for fluid milk is highly inelastic — that is, it does not vary much with price. A 1938-1940 study in New York City showed a change in milk consumption of only 0.33 percent for every 1-percent change in price.[1] Another study (1948-1949) in Connecticut showed a 0.48-percent change in consumption for each 1-percent price change.[2]

Results of more recent studies, as well as of one earlier study, tend to change the above conclusions. For example, milk prices in Syracuse, Utica, and Binghamton, New York, rose 3 cents a quart in 1957 after these markets were included in the New York Federal Milk Order. As a result per capita sales fell 0.8 percent for each percent price increase.[3]

In Kansas City the price dropped 6 cents per quart between the first 6 months of 1952 and the last 6 months of 1954. This sharp decline resulted in a 1-percent increase in sales for each 1-percent decrease in price.[4]

In an earlier (1940) experimental study in Washington, D. C., the price of milk dropped from 12 cents a quart to 5 cents a quart. As a result, sales to whites increased 1.15 percent, and sales to Negroes increased 1.4 percent, for each 1-percent price decrease.[5]

These studies indicate that the greater the price change, *the greater will be the inverse effect upon the per capita sale of milk.*

It seems reasonable to assume that the elasticity of demand for concentrated milk will correspond closely to that for fluid milk. If this holds true, the sharp price decreases possible from the marketing of concentrated milk are likely to result in much greater increases in per capita sales than those reported in New York and Connecticut. In fact, per capita sales of milk, including whole and concentrate, may increase as much as 15 or 20 percent.

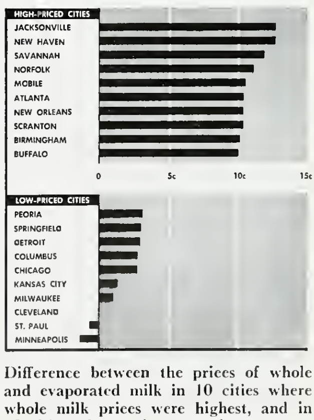
Changes in the Dairy Industry

The general acceptance of concentrated milk would not only bring sharp price decreases in many areas and greatly increase per capita sales of milk, but would also change the pattern of milk production.

Production could be expected to decline in high-cost areas and increase in low-cost areas. Milk prices to producers in low-cost areas would likely be somewhat higher than they are now. On the other hand, both Class I prices and blend prices, as well as distribution margins, could be expected to decrease sharply in high-cost areas.

All this is based on two main assumptions — that the trade barriers now existing against concentrated milk can be broken down, and that this product can win its spurs in a toughly competitive field.

It seems likely that the trade barriers will disappear within the next few years, although one and possibly two Supreme Court decisions may be necessary first. The success of concentrated milk in California indicates that, once the trade barriers are broken, concentrated milk can become widely accepted.



Difference between the prices of whole and evaporated milk in 10 cities where whole milk prices were highest, and in 10 cities where prices were lowest.

[1] N. Y. (Cornell) Agr. Exp. Sta. Bul. 765, 1941.
[2] Conn. (Storrs) Agr. Exp. Sta. Bul. 280, 1951.
[3] Based on information presented by Dr. Leland Spencer to the Annual Conference of Federal Milk Market Administrators, New York, Nov. 12, 1958.
[4] Jour. Farm Econ., Aug., 1956, pp. 889-890.
[5] Adapted from U. S. Dept. of Agr. Cir. 645, 1942.

Biological Control of PLANT NEMATODES

"It takes a thief to catch a thief" — and it sometimes takes a nematode to catch a nematode

M. B. LINFORD

Most living things have natural enemies — predators or parasites — that either kill them for food or limit their development and multiplication. Control of harmful pests or diseases by such natural enemies is called biological control.

In having natural enemies the plant-parasitic nematodes are no exception. These microscopic worms that feed in or on the roots and other parts of plants are attacked by a great many living things in the soil, including fungi, protozoa, small soil insects and mites, and several distinct kinds of predaceous nematodes.

Numerous observations have convinced us that sometimes plant nematodes are controlled rather well by their enemies but that at other times they are controlled very little. In Hawaii, for example, where I began work on nematodes before coming to Illinois, we saw good natural control in some garden plots. In pineapple fields, however, nematodes caused severe damage even where many of their natural enemies were present.

Expensive control measures, such as soil fumigation, can profitably be used for pineapple and other intensively grown crops that have a high acre value. As a rule, however, fumigants are much too costly to use in growing such major Illinois crops as corn, soybeans, small grains, and hay. Less expensive means of controlling nematodes are needed here.

One possibility, which we are now exploring in the Department of Plant Pathology, may be to increase the biological control of these pests.

M. B. Linford, Professor of Plant Pathology, came to the University of Illinois about 10 years ago, after 20 years with the Pineapple Research Institute in Honolulu.

Nematode Situation Not Now Serious in Illinois

Fortunately our nematode problems in Illinois are at present generally mild. This is partly due to our predominantly heavy soils — nematodes are most destructive in the lighter soils. Our crop rotations, including crops that add organic matter, also help. Our winters seem to save us from those nematodes that need a warm climate. Finally, it appears that biological control often is more active here than in many of the regions where nematode troubles have become acute.

What We Are Trying to Find Out

Even though nematodes are not a general problem in this state, we do sometimes encounter very severe nematode injury in Illinois fields and gardens. Hence we cannot assume that we are safe from future troubles.

To guard against such troubles we are very much interested in learning (1) how much benefit we now receive from biological control, (2) what precautions we must take to avoid losing such benefit, and (3) what we can do to increase the degree of biological control. To meet these objectives we need to know as much as possible about the various natural enemies of nematodes.

Predaceous Nematodes Studied

We are now studying some of the predaceous nematodes that thrive on a diet of other kinds of nematodes. Other agents that kill nematodes merit study too, but we cannot work on all phases of the problem at once, and the fungi that destroy nematodes are being studied actively in England.

Our interest is concentrated on nematodes of the *Aphelenchoides* or *Seinura* group. While in Hawaii, I encountered several species of this group. These were tropical species, but since coming to Illinois, I have repeatedly found species of this same group. Some of them survive our winters even north of Chicago.

Fortunately, it is possible to rear these species in the laboratory under conditions that let us study their life history and rate of multiplication. To feed them we first rear another kind of nematode, an *Aphelenchus,* as prey. This nematode thrives in laboratory cultures of a fungus.

Building and maintaining cultures is somewhat involved. First we must get rid of bacteria and stay rid of them. We start a culture of the fungus, then add a moderate number of the prey. After giving the prey time to multiply we add a few predators.

We can rear up to 100,000 of the prey in one culture dish about 3½

inches in diameter. Before that many have developed, however, we add predators, and soon they have multiplied so much and killed so voraciously that the prey are eradicated. Then new cultures are needed.

One species of predator has been studied in detail by Miss H. Carol Hechler while earning a Master's degree in plant pathology. This species can lay 12 eggs a day. These hatch in about 1½ days and during the next half day begin killing and feeding. They are mature and laying eggs within 6 days, while their mothers are still productive. About half of these nematodes are males. Even so, the population can multiply more than 1,000-fold during 2 weeks. None of the harmful, plant-parasitic nematodes are known to multiply this fast.

Some of the related species of predators multiply more rapidly and some less. Nearly all the members of some species are females and the few males seem not to be needed. These species differ in still other ways that need not be mentioned here.

Which Species Is Best to Use in Biological Control?

Our work in the laboratory has shown that we can rear huge numbers of predaceous nematodes for addition to soil in greenhouses, gardens, or fields. But we don't yet know which species may be most promising for use in planned biological control. In fact, we don't know whether any of them will do enough good to justify the costs. We cannot expect them to multiply or kill nematodes as fast in soil as in the laboratory. They will not find their prey as readily in the soil, and the moisture supply, temperature, and oxygen supply will not always be as suitable as in the laboratory.

We are now trying to learn how effectively any of these predators can control plant-parasitic nematodes in the greenhouse. Also, we are trying to devise reliable tests to determine the relative merits of the different species.

Other Studies

While concentrating our attention on the *Aphelenchoides* group of nematodes, we are also making observations on other types of predators that currently are found more frequently in Illinois but that multiply less rapidly. They are more difficult to study and rear with present methods.

Perhaps there are totally different biological agents, still unrecognized, that can help to control harmful nematodes. We are constantly watching for such organisms while pushing ahead with our investigations of the predaceous nematodes.

In the picture at right, a predaceous nematode (the one with a long, thin tail) is feeding on a nematode that it has recently paralyzed and killed. This type of predator uses a mouth "stylet," like a microscopic hypodermic needle, to inject saliva into its prey and suck out body contents as food. Both nematodes were actually less than 1/25 inch long. (Fig. 1)

The stylet of the predator inserted into the prey is shown at higher magnification in the picture below. The prey here is nearly empty, most of its body contents having been sucked out by the predator. (Fig. 2)

What People Like in WOOD PANELING

C. S. WALTERS, author of this report, is Professor of Forestry. He does teaching and research on the harvesting, processing, and use of wood. Much of his research has been on methods of wood preservation.

NEARLY EVERYONE likes wood paneling in the home. But preferences differ as to kind of wood, type of finish, and the best places to use paneling.

Some of these differences, as well as points of agreement, have been brought out in a study by the Illinois Agricultural Experiment Station. The study was part of a broad forest-products marketing research project involving several North Central states. Illinois' portion of the investigation was to interview randomly selected Urbana homeowners about their likes and dislikes.

Of the 23 people interviewed, all except one were housewives; one husband ventured to express views that did not agree with those of his wife. The interviewees lived in all parts of the city. Incomes varied from less than $4,000 to more than $10,000 a year.

Some homes had been planned by the present owners, and others had been purchased already built. Estimated value of the homes (with lot) ranged from $10,000 to over $20,000, with 82 percent falling in the $10,000 to $20,000 class. Many of the homes were relatively new, less than 3 years old; about half of them were less than 10 years old.

Why did we bother these homeowners with our questions? The basic reason was to learn if paneling could be developed as a market for low-grade oak lumber. About 60 percent of the timber in Illinois is oak. Much of the oak lumber sawn at the present time is low-grade, containing knots, slight decay, or other imperfections. Good markets have been developed for some kinds of low-grade softwood lumber — for example, pecky cypress, knotty pine, and white-pocket fir — by selling defects such as knots, decay, and worm holes as "character marks." Low-grade oak also is "character marked," but its pleasing appearance has not been brought to the attention of the general public.

How Widely Was Paneling Used?

About one-third of the homes visited already had wood paneling, but none of it was native hardwood. Pecky cypress, knotty pine, western red cedar, and Philippine mahogany were the woods used.

All the people interviewed were asked in what room they would "most likely use oak paneling." Most of them chose the family room, study, recreation room, or den. One lady chose the kitchen, and two, the living room.

Paneling is less likely to become monotonous or lose its appeal if it is combined with plastered or papered walls. Thus it was surprising to learn that most of the people interviewed preferred paneling on all four walls.

Kind of Wood Preferred

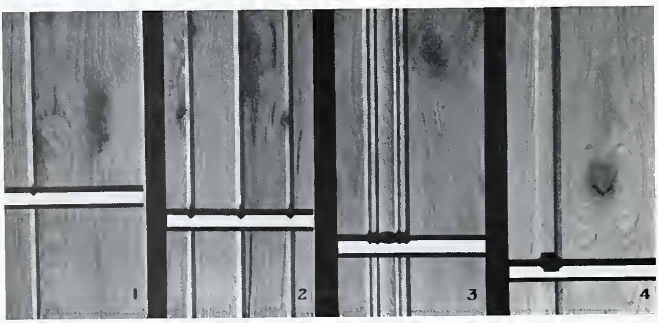
Samples of knotty pine, western red cedar with knots, Philippine mahogany plywood, and red oak with knots were displayed, and each person was asked to indicate a preference. Forty-eight percent selected mahogany; and 35 percent, western red cedar. Red oak and knotty pine were less popular.

Although light-colored woods are popular now, the darker woods may soon be occupying top place. Species preferences shift from time to time as furniture styles change.

What Kind of Finish?

Most of us agree that the beauty of a wood depends upon how it is finished, but we may disagree upon the definition of "beauty." And, like species preferences, opinions about finish change over the years.

For the survey, four samples of oak paneling had been finished in different ways. Three of the four had received these stains: (1) dark walnut; (2) golden oak, a somewhat lighter stain; and (3) limed oak, obtained with a coat of white wip-



Cross-sections of these four milling patterns are shown in white at the bottom of the boards. The paneling was made from native red oak lumber. (Fig. 1)

Four grades of native red oak paneling: W, Wapello; O, Osage; M, Montauk; and S, Shawnee. *(Photo: University of Missouri School of Forestry)* **(Fig. 2)**

ing stain. The fourth was not stained. All were brushed with two coats of clear brushing lacquer.

Nobody liked the dark walnut and only 12 percent preferred the golden oak. About 42 percent, however, liked the limed oak, and 46 percent liked the clear finish. Thus it seems that the best market now is for light-colored paneling.

Milling Pattern

The 23 homeowners were asked which of four patterns of oak paneling (Fig. 1) they liked best. They were shown colored stereoslides of entire walls paneled in these patterns, as well as hand samples of actual board. The single V-groove (No. 1, Fig. 1) was most popular, receiving 45 percent of the choices. The next most popular pattern was the single, broad channel (No. 4, Fig. 1) developed by University of Missouri wood technologists.

Quality of Wood

Four grades of oak paneling were included in preference tests (Fig. 2). Homeowners were first asked to choose a grade without considering price. Forty percent chose Wapello, the clear grade. However, an encouraging result, as far as our marketing problem is concerned, was the fact that about a third of the homeowners preferred Osage, the grade which permits a small number of character marks in the boards. Twenty-one percent of the persons chose Montauk, which allows knots and holes. Thus about half the persons chose paneling which could be made from relatively low-grade lumber. Only one person chose the Shawnee grade, which permits large knots and holes.

To find out whether the same choices would be made if price were considered, we assigned the following retail prices to a quantity of paneling that would cover a wall 8 x 12 feet (excluding installation costs): Wapello, \$45; Osage, \$35; Montauk, \$24; Shawnee, \$22.

Some people chose a lower grade when they considered price as well as appearance. Montauk, for example, picked up several more votes. Here is the comparison:

Paneling grade	*Percent of total choices*	
	Price unknown	*Price known*
Wapello	42	35
Osage	33	25
Montauk	21	40
Shawnee	4	0

How Wide Should Boards Be?

Board width is important in paneling from the standpoint not only of appearance, but also of service. Wide boards shrink (or swell if the relative humidity rises) more than narrow boards, and they tend to "cup" or warp more. Therefore, they are harder to keep in place, and more likely to cause trouble.

To test the homeowners' preferences as to board width, we showed them colored stereoslides of walls paneled with boards of different widths. One wall was paneled with oak boards of random widths ranging from 3 to 7 inches. Another wall was paneled with 5-inch boards, and a third was covered with 7-inch boards. We asked whether boards wider than those shown were desirable, and 90 percent of the homeowners said no. About two-thirds liked the 7-inch paneling, and slightly less than a third preferred the 3- to 7-inch boards.

Wainscoting Popular

Wainscoting (Fig. 3) was popular a number of years ago, and there appears to be a trend toward returning to the fashion. About 58 percent of those interviewed indicated that they liked wainscoting well enough to use it in their homes.

Since wainscoting uses short boards, it probably could be manufactured and sold at a lower cost per square foot than the full-length paneling. It is also quite likely that the installation costs for wainscoting would be lower and "do-it-yourselfers" would find it easier to install than full-length paneling. Thus there are several good reasons for considering wainscoting as a potential market for oak lumber.

How Our Data Will Be Used

The data collected by the Illinois Station will be included in a final report with those obtained in other states. The findings will be used to expand present markets and create new markets for the farmer's wood crop.

Montauk grade of native oak wainscoting is combined with plaster on this wall. Baseboard and top moulding are also of oak. *(Photo: University of Missouri School of Forestry)* **(Fig. 3)**

Improved performance from

A Three-Auger Silo Unloader

ROBERT M. PEART

SILO UNLOADERS may operate on less power and have higher capacities as the result of studies in the Department of Agricultural Engineering.

Blower Replaced by Augers

The present-day unloader uses a rotating auger or gathering chains to collect the silage and deliver it to the center of the silo. There the silage is picked up by a blower-thrower and is delivered to the unloading chute. The blower is operated by a 3- to 5-horsepower motor.

In our studies we substituted vertical and horizontal motor-driven augers for the blower (Fig. 1). The vertical auger was mounted in the center of the silo. It was 2 feet by 12 inches and was driven by a 1½-horsepower motor. It picked up the silage and transferred it to a 9-inch horizontal auger, driven by a 1-horsepower motor, which delivered the material to the unloading chute.

Performance of the vertical auger was improved by welding 5/16-inch rods at 3-inch intervals on the inside of the auger housing. These rods or ribs were perpendicular to the edge of the auger flighting. The auger had a ½-inch clearance from the inside of the housing.

The ribs reduced rotation of silage about the auger, lowered power requirements, and improved carrying capacity. With the ribbed housing, the vertical auger moved 300 pounds of legume silage a minute, using only 1 horsepower.

This suggests that, on other augers, ribs in the casing may prove valuable for conveying grain and other materials.

Gathering Auger Tested

Experiments were also conducted with augers used for gathering silage and delivering it to the center of the silo.

In one test with legume silage, ¼-inch rods were placed along the top and back of the auger to prevent loss of silage from the back. They were spaced 2 inches apart, parallel to the shaft (Fig. 2). As on the vertical auger, the ribs improved performance and reduced power requirements.

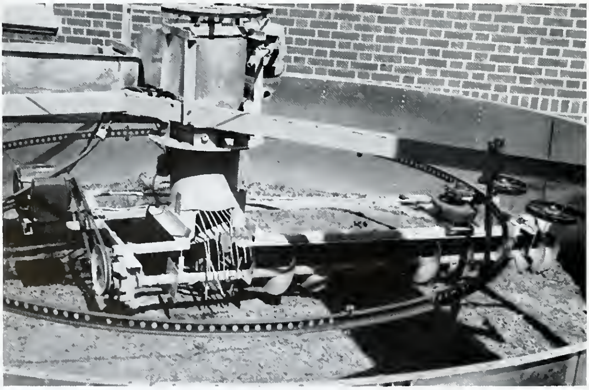
Advantages and Disadvantages of a Three-Auger Unloader

Power requirements are lower. This may make the three-auger unloader particularly valuable for large-diameter silos, where blowers may use excessive power.

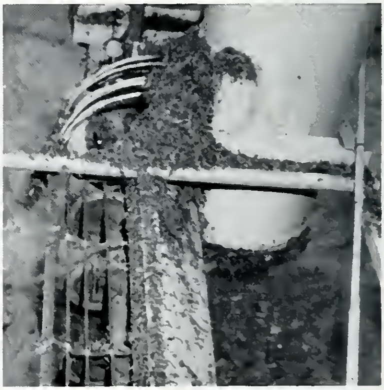
Unloading capacity is greater. This advantage may be especially important when silage is delivered to waiting wagons. It is less important when silage is handled by automatic feeding systems.

One disadvantage is that three motors are needed instead of two. Another is that the mechanism is as complicated and heavy as the blower-thrower.

Robert M. Peart, Assistant Professor of Agricultural Engineering, has leave of absence this year to do advanced study under a National Science Foundation fellowship.



The experimental all-auger silo unloader. The gathering auger brought silage to the center, and the 12-inch vertical auger lifted it to the delivery auger (upper left), which carried the silage to the door. (Fig. 1)



A rib-lined shield on the gathering auger may make it easier to move grass silage, as well as legume silage. (Fig. 2)

CAREERS for the Graduate in AGRICULTURE

WARREN K. WESSELS

"WHAT are the employment opportunities for a person with college training in agriculture?" is a question frequently asked by prospective students and their parents.

About 15,000 jobs await agricultural college graduates every year. These jobs represent a variety of rewarding and challenging careers, as the following brief descriptions indicate.

Agricultural Science and Research

Many unsolved problems face agriculture, offering practically unlimited opportunities to young folks who want to do research. People trained for research work may find employment in business and industry, governmental agencies, universities, and other organizations.

Researchers work in all phases of agriculture — from developing new products to perfecting new disease-control methods. Price and market analysis is an area that holds great promise. Advanced training in agricultural economics is especially helpful for this type of work.

Agricultural Business

The "agri-business" field is expanding rapidly. More people are employed in processing, marketing, and distributing agricultural products than in actual farm production.

The person interested in an agri-business career should have training in the agricultural sciences, natural sciences, economics, social sciences, business administration, finance, communications, and the humanities. Such training prepares not only the students who want jobs in business and industry, but also those who are interested in farm finance and credit, insurance, and farm management services.

Selling and marketing offer the greatest opportunities in agri-business. Manufacturers of feed, fertilizer, machinery, equipment, and other agricultural supplies are constantly in need of personnel interested in sales and sales management. People in sales work have excellent opportunities to advance to higher management positions.

Graduates with majors in agronomy who have a desire to sell will find many good opportunities in the agricultural chemical and plant food industries. Similar positions are available for those with training in animal science, dairy science, horticulture, and agricultural engineering. The food distribution and processing industries annually require many people who are trained in dairy and food technology.

Services

Public and private agriculture services offer real opportunities for those desiring to serve agriculture. The U. S. Soil Conservation Service and Forestry Service employ large numbers of college-trained personnel. Experienced and well-trained agricultural specialists can work abroad under the auspices of various technical aid programs. Careers in livestock and meat inspection, grain inspection, and state and federal crop reporting are available for those who are interested.

Agricultural Education

Vocational agriculture teaching and extension work offer major opportunities for those interested in education. More college teachers will be needed also as the enrolments of our colleges increase. Many agricultural businesses employ people to teach and work with farmers and sales personnel. Well-known agricultural organizations and farm foundations are staffed with people having training and experience in agricultural education.

Farming

As the business of farming becomes more technical and complicated, college training in agriculture becomes more valuable for those who want to farm. College training will enable a potential good farmer to be a better farmer. In addition, it will make him better able to assume leadership in agriculture. The need for such leadership — in the state and nation as well as the community — can best be served by those who are farming.

Agricultural Journalism

Getting agricultural news and information to the public is an important job. Journalists with good technical agriculture backgrounds and farm experience are in demand by newspapers, farm magazines, and trade journals. Radio and the expanding field of television also offer excellent possibilities to people with the necessary talent.

Placement of Graduates

The placement office of the College of Agriculture has standing requests from over 100 companies who are interested in talking with graduates about employment. Many companies regularly send representatives to the campus to recruit graduates. The many contacts of the faculty are also helpful in placing graduates.

Salary ranges are quite difficult to pinpoint. The beginning wage depends upon many factors. Many Illinois graduates take jobs that start at $350 to $425.

Other considerations besides salary are important — for example, degree of responsibility, opportunity for advancement, and a sincere liking for one's work.

Warren K. Wessels, Instructor in Agriculture and Assistant to the Dean, is in charge of the placement of graduates.

Extension Workers Study COMMUNICATIONS METHODS

ERNEST W. ANDERSON

AGRICULTURAL AND HOME ECONOMICS Extension is a connecting link between the research worker and the interested public.

The Extension worker's job — helping people on farms and in homes to use the results of research — is becoming increasingly difficult. The problems attacked by research workers are becoming more involved and more specialized each year, and farm and home life is also becoming more complicated. Extension workers therefore need to have specific and accurate information on an increasing variety of subjects.

As the scope and complexity of subject matter increases, skill in communicating ideas and information grows more important. Extension workers throughout the nation are therefore trying to become better communicators.

In 1953 the National Extension Committee on Organization and Policy (commonly known as ECOP) began a study of serious problems in Extension education. Out of this study grew a "Communication Training Program" for improving Extension teaching methods. The program was developed by ECOP, the American Association of Agricultural College Editors, and the National Project in Agricultural Communications (NPAC), a group sponsored by the Kellogg Foundation. NPAC worked out details of the program, which has included several workshops in communications.

Illinois Staff Attend Workshops

The first NPAC workshop was in August, 1956, and lasted 3 weeks. About 10 days were devoted to studying basic concepts of communication and the rest of the time was spent on person-to-person communication and techniques for working with groups.

Four people from the University of Illinois attended this first workshop, and four more attended a similar workshop last summer at Fort Collins, Colorado. During the fall of 1958 NPAC conducted a training program on written communications, and another four-person team from Illinois took part.

The workshops were developed on a "train-the-trainer" basis. This means that the people who attended them were expected to become teachers of other Extension workers when they returned to their respective campuses across the country. This concept is being carried out at the University of Illinois in the Extension training program.

Communications Studied in District Meetings

For the last two years, materials and ideas from the communications workshops have been presented at the January and September district training meetings for Extension workers. The following ideas have been emphasized:

Communication is basic to all teaching. If the teacher does not communicate with the learner, there can be little or no meaningful learning.

Communication is a two-way process. The fundamental purpose of all communication is to understand another person's meaning and, in turn, for him to understand yours. As a teacher follows this principle, he becomes conscious of the effects his words and actions are having on other people. This "feedback" determines what next a teacher should say or do.

Being "other-person-conscious" is necessary in person-to-person conferences, in group meetings, and in written communications.

Successful group meetings depend on effective communication. People learn more from one another than we usually realize. An important role of the Extension worker is to help the members of a group communicate their ideas. Out of effective communication comes effective group action.

Skill in written communication is important. Extension workers communicate with many people through personal columns, newsletters, personal letters, and other writing. Written communications were therefore emphasized in the last series of district meetings. It was suggested that the best way to develop as a writer is to become critical of one's own written material. This puts the writer in the role of the final reader.

By following these principles, Extension workers are trying to be more effective in helping people to understand the increasing complexity of our modern world.

Ernest W. Anderson is Associate Professor of Agricultural Extension, and Assistant State Leader of Farm Advisers.

COMING EVENTS

(A partial list of meetings scheduled at Urbana)

April 15-16: Illinois Bankers' Conference

April 21-22: Grain Dealers' Management Conference

May 11-15: Leisurecraft and Counseling Conference (4-H Memorial Camp)

May 21-22: Conference of Production Credit Association Fieldmen

June 9-11: Illinois Vocational Agriculture Teachers Summer Conference

June 15-17: American Dairy Science Association Meeting

June 24: Annual Agronomy Day for Farmers

June 29-30 (tentative): Fertilizer Industry Conference

RESEARCH IN BRIEF

Automotive Dry Air Cleaners Not Satisfactory for Tractors

During the last 2 years the Department of Agricultural Engineering has been testing dry-type air cleaners on farm tractors. The cleaners tested were similar to those used on late-model automobiles. Results show that the automotive dry-type cleaners are not good enough to replace the oil-bath cleaners on tractors.

Dust-separating efficiency of the automotive dry-type cleaner was satisfactory in the laboratory. However, this did not hold true in field tests. Three tractors with dry-type cleaners suffered excessive engine wear.

Many tractor operators using this type of cleaner have also reported engine wear. Moreover, they have found cracks in the paper and damage on the sealing surfaces after relatively little use.

At present, the only recommended use of the automotive dry-type cleaner on tractors is as a precleaner above the oil-bath cleaner (see picture). This will eliminate a lot of the regular oil changes and problems with chaff in oil-bath cleaners.

The dry-type cleaner does have other advantages. When substituted for the oil-bath cleaner in tests, it increased horsepower by about 3 percent. This was due partly to the way the cleaner was attached to the carburetor. Also, air can be drawn through the dry-type cleaner easier than through the oil-bath cleaner.

Manufacturers and the Department of Agricultural Engineering are now testing different dry-type cleaners to find one suitable for tractors (see picture). Ultimately one should be perfected that will give tractor operators the advantages of this type of cleaner. — *J. C. Siemens*

Dry-type air cleaner at left has been designed for tractors and is one of several being tested. Only recommended use of the automotive dry-type cleaner on tractors is above oil-bath cleaner (right).

Liquid Fertilizers Prove As Effective As Dry Mixtures

Liquid mixed fertilizers proved to be just as good as, but no better than, equal amounts of dry mixtures when applied to corn at three locations in 1958. The tests were conducted at Elwood, and at the Agronomy South Farm and Agricultural Engineering Farm in Urbana.

A 12-6-6 grade liquid fertilizer, applied at 800 and 1,600 pounds an acre, was compared with the same grade and same rates of a dry mixture broadcast and plowed down ahead of corn. In addition, an 8-16-0 grade of both liquid and dry mixes, applied at a 100-pound rate, was banded near the seed at planting time. Populations of 12,000 and 16,000 plants an acre were used at each location.

The addition of plant nutrients to deficient soils markedly increased yields. Liquid and dry mixes were equally effective in providing the increases. As an average at all locations, corn yields were increased 12 bushels an acre by increasing the population from 12,000 to 16,000 plants an acre. This, however, did not change the effectiveness of either the liquid or dry fertilizers.

Liquid fertilizers are rapidly gaining popularity and are now widely available to Illinois farmers. A liquid fertilizer may contain one or more available plant nutrients. The most common liquid fertilizers in Illinois contain only nitrogen; nitrogen and phosphorus; or nitrogen, phosphorus, and potassium.

The experiments reported here indicate that the choice between liquid and dry mixes will have to be determined by fit, convenience of handling, and price — not by yield potential. — *A. L. Lang*

Spray for Treatment of Manganese Deficiency

In the spring and early summer of 1958 many farmers in northern Illinois reported leaf injuries in oats and soybeans. The symptoms suggested an inadequate level of manganese. This was confirmed by chemical analysis of the foliage, which showed a strong correlation between injury and low manganese concentration.

Soybeans in Mason and Lee counties were sprayed with solutions of manganese sulfate. Except for badly damaged leaves, plants resumed growth and regained normal color within 2 weeks. Minimum yield increase was 6 bushels an acre.

Applying manganese to the soil was not a successful remedy. Negative results were also obtained in greenhouse trials, in which soils brought in from the field were fertilized with manganese. Soil applications have also been found ineffective in other states.

Most soils are not actually deficient in manganese, but they may have it in a form unavailable to the plant. Although manganese can be added to the soil in a readily available form, the soil can rapidly convert it to an unavailable form under certain conditions. These conditions are low soil moisture, high temperature, adequate aeration, and alkaline soil reaction.

Plants seem to have a higher requirement for manganese — or an inability to absorb adequate amounts — under conditions of high moisture, low temperature, and low light intensity. The problem of manganese deficiency thus involves both supply in the soil and demand by the plant. As a result, plants can show deficiency under diverse conditions. The Department of Agronomy will continue to investigate this problem.

On the basis of the trials reported here, leaf sprays are recommended as the best method of controlling manganese deficiency in crop plants. Consult with your county farm adviser for diagnosis of manganese deficiency and recommended spray treatment. — *R. H. Hageman*

Mist Helps Cuttings Root

Most home gardeners have, at one time or another, taken a "slip" from a neighbor's cherished plant and rooted it in moist sand or even in a glass of water. A new propagation technique, widely accepted by florists and nurserymen, may be very helpful to the amateur gardener who is interested in plants not usually grown from seed. Work in the Department of Horticulture has been important in the development of this technique.

The technique consists of using mist on cuttings fully exposed to the brightest sun available. Since mist has a cooling effect, it is most needed during the heat of the summer. At this time the sun is brightest and most beneficial to the cutting. Also, growth is less hard during the summer and consequently rooting is faster.

It is suggested that a bed of sand approximately 6 inches deep be made with a mist nozzle overhead. If this is located out-of-doors in full sun, crop after crop of fine-rooted cuttings may be produced during the summer.

Suggestions about equipment for mist propagation have been prepared by the Department of Horticulture and may be had on request. — *J. R. Kamp*

Wheat-Agropyron Hybrids a Possible Source of Resistance to Loose Smut

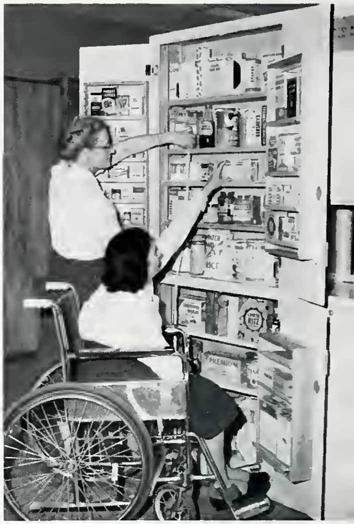
For many years geneticists have been hybridizing common wheat (*Triticum vulgare*) with Agropyron grasses, particularly *Agropyron elongatum,* attempting to develop strains of wheat with a high degree of resistance to many diseases. From these hybrids many selections have been made and a number of wheat-like lines have proven of interest because of their resistance to the common diseases of wheat. Selected progeny have been outstanding in their resistance to wheat leaf rust (*Puccinia rubigo vera tritici*) and black stem rust (*Puccinia graminis tritici*).

There also is a need for wheats with greater resistance to loose smut. Hybrids of wheat and *Agropyron elongatum,* which is immune to this disease, have been tested for such resistance in the Department of Plant Pathology.

Seed of 32 promising selections was obtained from W. J. Sando, geneticist of the Agricultural Research Service. The seed was then inoculated with six different races of loose smut (*Ustilago tritici*), namely races 1, 5, 6, 7, 11, and 16. The mature inoculated seed was planted in pots in the greenhouse, and grown until it headed out. At this time data were taken on the relative resistance or susceptibility to the races of loose smut.

All the selections with pronounced wheat-like characteristics were susceptible to some race of smut. None of these, however, were susceptible to all six races. Two were susceptible to races 1, 6, 7, and 16. One was susceptible to three races, and the others were susceptible to only one or two races. All of the selections that were predominantly of the Agropyron type were highly resistant or immune to the six races of loose smut.

Where only certain races of smut are present, the proper hybrid might furnish a source of resistance to these races. — *W. M. Bever.*



Testing reach into a shallow cupboard.

"Wheel-Chair" Kitchens Are Developed

Of the estimated 8 million physically disabled women in the United States, many are confined to wheel chairs. Kitchen arrangements suitable for these women are being developed in the Department of Home Economics. It is aimed to make work from the wheel chair safer and easier, while departing from normal housing design as little as possible.

Twenty-six women who are confined to wheel chairs have been measured for range of reach, comfortable working heights, necessary clearances for knees and chair, and space requirements for maneuvering the chair. The women have tried many types of kitchen and laundry appliances, and also storage units of both conventional and special design.

Experimental kitchen units, based on the needs of the 26 women, are now being tested in the housing research laboratory. These units represent a variety of possible arrangements. Women in wheel chairs will prepare meals in each of the units as

a further test of dimensions and convenience.

Descriptions of the most satisfactory designs will then be published, and a permanent kitchen will be built for display purposes.—*Helen E. McCullough and Mary B. Farnham*

Feeding High Levels of Protein Does Not Control Caked Udder

Feeding high levels of protein before and after calving neither reduces nor increases the incidence of parturition edema or caked udder.

Previous research has shown that the blood protein falls to a low level at calving time. This drop is due to the heavy demand for protein to make colostrum. The fall is more critical in heifers than in older cows, since heifers have a lower blood protein level to start with. This may explain why parturition edema is more frequent in heifers.

Since it seemed likely that the low blood protein might be responsible for the udder edema, the blood protein of several heifers with severe edema was increased by transfusions of bovine serum albumin directly into the blood. The edema disappeared almost completely within 24 hours.

Because high cost makes these transfusions impractical at present, an experiment was conducted in which high levels of protein were fed just before and after calving in an effort to raise the blood protein level. Starting 6 weeks before calving, twelve Holstein, Ayrshire, and Jersey heifers were fed 6 pounds of soybean oil meal daily in addition to good-quality roughage. This did not increase blood protein levels nor reduce the number of edema cases. On the other hand, none of the heifers fed the high-protein ration had severe edema.

Other trials at the University of Illinois and elsewhere have also shown that feeding liberal amounts of concentrate just before calving has not affected the incidence of udder edema. — *R. L. Hays and B. L. Larson*

Some Uncommon Turf Grasses and Ground Covers Are Tried

Home owners seeking to improve their lawns are inquiring about some of the less common grasses and ground covers, such as Zoysia, Mondo grass, and Dichondra.

Meyer Zoysia is a grass which thrives in a warm climate. While it is hardy in central Illinois, it has spread rather slowly in experiments at Urbana. Emerald Zoysia has finer leaves than the Meyer variety, but is less vigorous.

Zoysia is available from nurseries and garden shops. It can be planted at any time during the spring and summer. For reasons of economy, small pieces of sod or pieces of runners are planted, usually a foot apart. It takes about two years for the grass to fill in the space. During this period, the ground should be kept free of weeds, and fertilizer used freely.

Once established, Zoysia makes a close turf that is practically weed-free and stands heavy wear. It turns yellow with the onset of cool weather, however, and remains in this condition until warm weather in the spring. A semblance of green color can be maintained in winter by means of a dye.

A warm-climate plant, not a grass, that has been tried for ground cover is known as Mondo grass or lilyturf. This plant has slender leaves which reach a length of slightly less than a foot. While it is hardy in central Illinois, the clumps spread little or not at all, and it has not proved to be a suitable substitute for grass.

Dichondra or lawnleaf has small leaves that resemble violet leaves but are less than an inch across. The plant is used to some extent for lawns in southern California, but it has not proved hardy in Illinois. — *F. F. Weinard*

A New Root Rot of Alfalfa

A new root rot disease of alfalfa was found in Illinois in the spring of 1957. Before this time the disease had been known only in California. So far the disease has occurred in only a few scattered fields in Illinois; however, where it has been found, it has either completely destroyed stands or has rendered them unproductive. If this disease should become more widespread, it would be a serious threat to alfalfa production.

Thus far the disease has been found only in first- and second-year stands. Damage has been most severe in heavy, poorly drained soil, and is probably favored by cool, wet weather.

Symptoms of the disease vary, depending on how rapidly it develops. If conditions are very favorable for the disease, healthy-appearing alfalfa plants may suddenly wilt and die. On the other hand, if the disease develops more slowly, the plants become stunted, the leaves become yellow, and eventually the plant is killed.

This disease is caused by a fungus, *Phytophthora cryptogea*, that lives in the soil. The fungus attacks the alfalfa taproot and produces a brown to yellow soft rot. If one tries to pull a dead plant, the root breaks and the plant is easily removed from the soil.

All the common varieties of alfalfa grown in Illinois are susceptible. The variety, Lahontan, has some resistance to root rot, but it is not adapted to the Midwest.

The best hope for control appears to be the development of resistant varieties that are adapted to Illinois. Once the fungus becomes established in a field, eradication is probably not practical. — *J. W. Gerdemann*

Green Is for Spring

Are you wondering why we changed the color of the cover?

The reason is that we're planning a four-season rotation of color and green seemed the right one for spring. By next winter we expect to be back to red again.

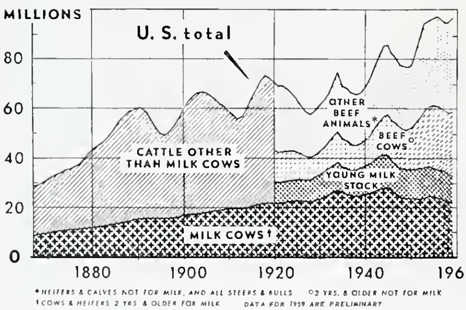
FARM BUSINESS TRENDS

Industrial Activity. The level of business during the winter was about "normal." The rate of industrial output swelled to the all-time high set in August, 1957. But about 7 percent of the labor force was still unemployed, the same as a year ago.

Increased spending by federal, state, and local governments gave business a big boost in 1958. Federal spending is now leveling off. Business has recently been spending to build up stocks against mid-year strikes. This kind of spending will decrease after a few months. Consumers have pushed their spending to a new all-time high, but their large debts may limit further increases.

Biggest uncertainty in the present business outlook is Congress. How much will it vote to spend in the year beginning July 1?

Hogs. The 1958 fall pig crop was 19 percent above the 10-year average. As a result, hog marketings have been unusually large since January 1 and can be expected to remain so throughout the spring. The 1959 spring pig crop, however, is expected to be only 8 percent over the 10-year average. Thus, market supplies this year will not increase as much as usual from spring to fall.



Cattle on farms January 1, 1867-1959. While the number of dairy cattle has been decreasing since 1943, beef cattle numbers are greater than ever before.

Beef Cattle. Numbers of beef cattle increased by 4 million head in 1958, and were estimated at 64 million head at the beginning of this year. This was 2 million more than the record high set 3 years ago. Another large increase is expected this year, but slaughter may also increase moderately.

Dairy. Milk cow numbers decreased by more than 6 million in the past 14 years. The number on farms January 1 was estimated at 21.6 million, 600,000 less than a year ago. The estimated number on Illinois farms was 783,000, or 24,000 less than last year.

Corn. Total acreage planted to corn this year may be 5 to 10 percent greater than in 1958. However, the increase will be offset by reductions in acreages of other feed crops, and probably by lower yields. If growing conditions are average or below, total feed production will be less than in 1958. Feed consumption in 1959-60 may well exceed production. Price support for the 1959 corn crop will be at $1.12 a bushel, compared with $1.06 and $1.36 for the 1958 crop.

Soybeans. Excess stocks of soybeans will appear for the first time this fall. The carryover next October 1 is forecast at 50 million to 90 million bushels. Biggest previous carryover was the 21 million reported last October 1. The expected surplus is one reason why the price support level has been cut from $2.09 to $1.85.

Fact for Thought. Nearly a hundred years ago Congress passed the Homestead Act to distribute public lands in family-sized units of 160 acres. That was when a farmer could plow about 2 acres a day. Now a farmer can plow 10 times as much, but half the farms in Illinois are still 160 acres or less. — *L. H. Simerl, Professor of Agricultural Economics*

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Summer, 1959

ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

IN THIS ISSUE

Storing high-moisture shelled corn in conventional silos directly after harvest increases ease of handling corn, without greatly changing its feeding value (page 3).

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ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

CONTENTS

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Louis B. Howard...........Dean and Director
Tom S. Hamilton...........Associate Director
Adrian Janes..................Station Editor
Margery E. Suhre..Editor, ILLINOIS RESEARCH

THE EXTENSION SERVICE IN AGRICULTURE AND HOME ECONOMICS

is one of the three main divisions of the College of Agriculture. The other two are the Agricultural Experiment Station, which is responsible for research; and that part of the college which offers on-campus instruction for students.

The main difference between agricultural research and agricultural extension is that in research the emphasis is usually on ideas and things, while in extension the emphasis is on people. Of course, agricultural research relates to people too, but in a different way. When the research is underway, people engaged in it are usually studying and manipulating things. After the research is done, the Extension Services tries to let people know how the results can be applied to their problems.

Thus, the purpose of extension is to teach. Both state specialists and county farm and home advisers are engaged in this job. Extension teaching is devoted to helping people develop so that they have greater understanding and ability.

Usually the goal of extension is expressed as "helping people to help themselves." This phrase, however, is relatively meaningless unless people are willing to seek and receive help, know why they want help, and know what they want it to do — and unless the helpers know what help to give and how to give it. People succeed when they have positive goals and rely on the development of their own abilities to achieve these goals.

In future issues of ILLINOIS RESEARCH, the Extension Service will report from time to time on what it is doing to serve the people of this state more effectively. — *W. G. Kammlade, Associate Director*

Dr. Kammlade is rounding out his forty-fourth year at the University of Illinois. During his early years here, he worked for his Ph.D. degree, having received his B.S. at the University of Wisconsin in 1915. Before becoming Associate Director of the Extension Service in 1949, he was Professor of Animal Science, and had been working to develop the Dixon Springs Experiment Station in southern Illinois.

Harvesting, Ensiling, Feeding HIGH-MOISTURE SHELLED CORN

A year's study indicates that high-moisture corn, after storage in conventional, upright silos, about equals dry corn in feeding value

E. L. HANSEN, G. E. MITCHELL, E. E. HATFIELD, A. H. JENSEN, K. E. HARSHBARGER

The Illinois Experiment Station has just completed a year's study designed to answer as many questions as possible about the practice of harvesting high-moisture shelled corn and storing it in conventional upright silos.

This practice has been catching on rapidly among farmers for a number of obvious reasons: Harvesting can be earlier and faster; operations and equipment are at a minimum; storage costs are comparatively low; the storage is rodent-free; and mechanical feeding is simplified.

But how does the practice affect chemical composition, palatability, and feeding value? At what moisture content is it best to harvest the corn? These are some of the questions we have been trying to answer.

Corn Harvested at Four Moisture Contents

One variety of corn was planted on 120 acres. The field was divided into strips that contained two rows for each of four silos, plus two rows to be harvested as dry corn. The corn that was to be ensiled was harvested at moisture contents of approximately 35, 30, and 25 percent. The dry corn was used as control corn in all tests except the feeding trials with dairy cattle.

Corn was harvested with a self-propelled combine with corn head attachment. At 38 percent moisture the machine was operated one speed lower than when the moisture was at 35 percent or less. Heavy silks plugged the sieves at 38 percent, and some of the corn remained on the cob. At 35 percent and below little difficulty was experienced.

Field losses were lowest at about 30 percent kernel moisture. Following is a summary of combine losses:

Moisture content	35%	30%	25%	18%
Loss (bushels per acre)				
Ear loss (machine and detached)	.8	.8	2.7	5.4
Shelled loss (snapping rolls and separation)	2.6	1.6	2.3	2.1
Cylinder loss (on cobs)	5.2	2.4	2.4	.4
Total	8.6	4.8	7.4	7.9

Because of late planting and water damage, the yield of this corn was between 40 and 50 bushels per acre.

Black polyethylene was used to seal the top of the corn in the silos. A trench was dug around the edge of the corn, and the film was forced down and out against the silo walls. Doors were sealed by extending polyethylene about 4 inches past the edges.

Chemical Analyses

As each silo was filled, several samples of corn were analyzed. Similar weighed samples in cheesecloth bags were placed in the silos and analyzed when the corn was fed. The analyses were compared to determine nutrient changes during storage. As shown below, losses were not excessive:

Moisture content			
At harvest	25%	30%	35%
When fed	24%	29%	36%
Loss (percent)			
Dry matter	2.16	3.40	1.19
Gross energy	2.10	4.83	1.48
Crude protein	1.31	3.96	.33

Volume of Corn

High-moisture corn occupies more space per bushel than No. 2 corn. According to weight and volume checks, a bushel of corn with 25 percent moisture occupies 1.30 cubic feet; 30 percent, 1.41; and 33.5 percent, 1.48, as compared with 1.25 cubic feet for No. 2 corn. This means that the capacity of a given structure would be approximately 11 percent less for corn with 30 percent moisture than for No. 2 corn.

Unloading Silos

Top unloaders were used but were not entirely satisfactory. Some changes were necessary on the drive-wheels to obtain traction. Also, more corn was loosened than was removed, which may have caused more rapid top spoilage.

Removing 1 inch of corn a day did not keep ahead of top spoilage. In warm weather, 3 to 4 inches a day seem desirable.

AUTHORS of this report represent the three departments cooperating in the study — Agricultural Engineering, Animal Science, and Dairy Science. E. L. Hansen is Professor of Agricultural Engineering; G. E. Mitchell, E. E. Hatfield, and A. H. Jensen are all Assistant Professors of Animal Science; K. E. Harshbarger is Assistant Professor of Nutrition in the Department of Dairy Science. Project leaders were Professors Hansen, Harshbarger, U. S. Garrigus, J. H. Ramser, A. L. Neumann, and S. W. Terrill. The National Silo Association cooperated by arranging with four Illinois silo manufacturers to supply silos.

Lamb in a metabolism crate which provides for individual feed and water. Feces and urine are collected beneath the crate. From a chemical analysis of the intake and output of each lamb, it is possible to calculate the utilization of nutrients.

Table 1. — Apparent Digestibility of Dry Matter, Energy, and Nitrogen; and Apparent Utilization of Nitrogen in Growing-Fattening Lambs

Type of corn	Apparently digested			Nitrogen retained[c]
	Dry matter	Energy	Nitrogen	
	percent			
14.5%[a]	63.3	64.4	54.7	70.0
21.6%[a]	64.8	64.6	58.1	71.7
31.6%[a]	66.1	64.4	55.7	71.1
34.4%[a]	65.7	64.9	58.4	66.3
140° F.[b]	66.8	66.1	57.7	68.8
220° F.[b]	66.5	65.9	58.6	70.3

[a] Moisture content when fed. [b] Temperature at which corn was dried. [c] As percentage of apparently digested nitrogen.

Feeding Trials With Lambs

The ensiled high-moisture corns seemed to have about the same feeding value for lambs as dry corn. Six corns were tested, including the four already described, plus corn dried at 140° F. and at 220° F.

Seventy-two grade lambs, each randomly assigned to one of the six corns, were fed individually twice a day. Feeding rates were adjusted so that all animals received the same amount of corn dry matter daily — this was the amount contained in about 2 pounds of the 14.5-percent corn. In addition, the lambs received 1.4 pounds of a supplement-roughage mixture consisting of dehydrated corn cobs, 32 parts; alfalfa meal, 5 parts; molasses, 4 parts; soybean meal, 5 parts; complete mineral,[1] 4 parts; plus 10 milligrams of aureomycin and 1 gram of vitamin A and D concentrate[2] per pound of supplement.

A standard metabolism trial was conducted to measure the apparent digestibility of dry matter, energy, and nitrogen (protein), and also the apparent utilization of digested protein. No significant differences between rations were found (Table 1). Nitrogen balances averaged about 7 grams a day for all rations, indicating the lambs were being fed so that they grew rapidly.

Beef Cattle

Corns harvested and ensiled at 25 and 30 percent moisture were as good as dry corn in feeding trials with yearling Hereford heifers. This was not true, however, of corn harvested at 35 percent moisture. Heifers fed this corn ate about 2 pounds less corn a day than did heifers fed the other corns. This reduced intake resulted in slower and less efficient gains.

Altogether, 36 heifers were included in the trials. In addition to corn, each animal was fed 5.4 pounds of mixed hay and 1.4 pounds of soybean meal daily plus free-choice mineral. Results are shown in Table 2.

[1] As shown in Jour. An. Sci. 17, 299. 1958.
[2] 5,000 units A and 500 units D_2 per gram.

Table 2. — Performance of Beef Heifers
(112 Days)

Item measured	Type of corn[a] 18%	25%	30%	35%
Number of heifers	9	9	10	8
Average initial weight, lb.	738	770	743	754
Average daily gain, lb.	1.89	1.90	1.91	1.51
Average daily corn, lb.				
As fed	12.96	14.67	15.63	14.89
14.5-percent basis	12.96	13.03	12.99	11.15
Feed per hundredweight gain, lb.				
Corn (14.5-percent basis)	686.0	683.8	681.4	740.3
Hay	287.1	284.9	284.0	360.1
Soybean meal	74.9	74.3	74.6	93.5
Total	1048.0	1043.0	1040.0	1193.9
Feed cost per hundredweight gain	$19.93	$19.84	$19.79	$22.58

[a] Based on moisture content at harvest. When fed the corns were 14.5 percent (artificially dried); 24 percent, 29 percent, and 36 percent.

Swine

Swine didn't do as well on the three high-moisture corns as on dry corn.

Forty-eight crossbred pigs, averaging about 40 pounds in weight, were divided into eight groups of six pigs each. Four groups were confined to ⅛-acre plots of alfalfa-ladino clover, and four groups to 7-by-14-foot pens on a concrete feeding floor. The four corns were fed free choice on both pasture and drylot, and were provided daily in open troughs. In addition a supplement consisting of supplementary protein plus vitamins, minerals, and antibiotics, was available in a self-feeder in each lot.

Results of the first phase of the test, lasting 72 days, are shown in Table 3. Pigs on the field-dried corn gained fastest, and those on the 35-percent moisture corn, slowest. Average daily consumption of all three high-moisture corns was higher than that of field-dried corn. This increase was not great enough, however, to ensure equal intake of dry matter. Thus, on the average, feed required for a pound of gain was least on the 14-percent moisture corn. Pigs on 35-percent moisture corn consumed the most supplement for a pound of gain.

On drylot, during an additional 35-day period, pigs

Table 3. — Performance of Swine
(72 Days)

Item measured	14%	25%	30%	35%	Aver.
	Type of corn				
Aver. daily gain, lb.					
Drylot	1.39	1.20	1.27	.99	1.21
Pasture	1.24	1.02	1.10	.87	1.06
Aver.	1.31	1.11	1.18	.93	....
Feed per day, lb.					
Corn: Drylot	4.06	4.51	4.47	4.51	4.39
Pasture	3.97	4.34	4.34	4.34	4.25
Supplement: Drylot	.82	.86	.84	.85	.84
Pasture	.59	.48	.49	.47	.51
Feed per lb. gain, lb.					
Corn: Drylot	2.92	3.76	3.52	4.56	3.69
Pasture	3.20	4.25	3.94	4.99	4.09
Supplement: Drylot	.59	.72	.66	.86	.71
Pasture	.48	.47	.45	.54	.48

Table 4. — Performance of Holstein Heifers
(24 Weeks)

Item measured	14%	25%	30%	35%
	Type of corn			
Daily feed intake, lb.				
Corn	7.2	8.0	8.4	9.3
Soybean meal	1.0	1.0	1.0	1.0
Hay	9.0	9.0	9.0	9.0
Daily dry matter intake, lb.				
Corn	6.2	6.2	6.2	6.4
Soybean meal	0.9	0.9	0.9	0.9
Hay	8.0	8.0	8.0	8.0
Total	15.1	15.1	15.1	15.3
Weight gain per heifer, lb.				
Total	260	236	241	255
Average daily gain	1.55	1.40	1.43	1.52
Heart girth increase, in.	9.0	8.2	8.4	8.7
Withers increase, cm.	10.2	8.6	10.0	11.0
Feed efficiency, lb. dry matter per lb. gain	9.7	10.8	10.6	10.1

receiving the 30- and 35-percent moisture corn consumed proportionately more supplement than the other pigs.

Dairy Cattle

Dairy cattle appeared to make efficient use of high-moisture corn, but it was not superior to regular corn. Trials were conducted with 24 Holstein heifers and 27 Holstein and Brown Swiss cows.

The three high-moisture corns and one lot of regular corn were fed to the heifers. Feeding rates were adjusted to provide about the same amount of corn dry matter for each group. All the heifers were fed a high proportion of corn to obtain a better test of nutritive value. They also received limited amounts of hay and 1 pound of soybean meal daily.

Results are shown in Table 4. That the heifers gained fastest on dry corn may be partly due to the fact that this corn was grown on a different field than the high-

Table 5. — Performance of Milking Cows
(15 Weeks)

Item measured	25%	30%	35%
	Type of corn		
Daily feed intake, lb.			
Silage	52.5	53.3	54.0
Hay	5.9	5.9	5.9
Corn	10.3	11.6	12.6
Soybean meal	1.9	1.9	1.9
Daily dry matter intake, lb.			
Silage	14.7	14.6	15.1
Hay	5.3	5.4	5.3
Corn	8.0	8.6	8.6
Soybean meal	1.8	1.8	1.8
Total	29.8	30.4	30.8
Daily production of 4% milk, lb.	30.5	30.9	31.5
Aver. daily body weight changes, lb.	—.51	—.32	.03
Feed efficiency			
Roughage dry matter per 100 lb. live weight, lb.	1.61	1.61	1.64
Grain dry matter per lb. 4% milk, lb.	.32	.33	.33
Total dry matter per lb. 4% milk, lb.	.98	.98	.98

moisture corn. Also, the dry corn was ground. The high-moisture corn was not ground, since it was "softer" than regular corn. Whether grinding is needed to increase digestibility and utilization of high-moisture corn has not been determined.

The 27 milking cows were divided into three groups. Each group was fed one kind of high-moisture corn for 7 weeks, and then switched to another kind, so that all cows received all kinds of corn. The first 2 weeks of each 7-week period were used as a preliminary or adjustment period, and the last 5 weeks, as the test or experimental period. In addition to one kind of high-moisture corn, the cows were fed corn, sorghum, or oat silage; 6 pounds of hay a day; and 2 pounds of soybean meal-mineral mixture. As shown in Table 5, the three kinds of corn were about equal in feeding value.

Conclusions

From results thus far, it appears that factors other than feeding value — such as harvesting losses and cost of storage — would determine the method of harvesting, storing, and feeding corn. It also appears that if high-moisture shelled corn is to be stored in silos, it should be harvested as close to 30 percent moisture as possible.

This Holstein heifer is getting high-moisture corn.

Breeding NEW APPLE VARIETIES for Scab Resistance

D. F. DAYTON

Apple varieties immune to apple scab are a distinct possibility for the near future.

For some years now, apple breeding at the Illinois Agricultural Experiment Station, as well as at other stations, has been concentrated on the development of scab-immune varieties. Apple scab is probably the single most important disease of this fruit in all humid apple-producing areas of the world. It is caused by the fungus *Venturia inaequalis,* which attacks both the foliage and fruit. Control is possible with chemical sprays, but it is both exacting and very costly.

The breeding program is based on the discovery in 1943 that certain small-fruited crabapple trees of Asiatic origin are not only immune to apple scab but are able to transmit immunity to a high proportion of their seedlings. In 1946 a cooperative project was established between the agricultural experiment stations of Illinois and Purdue University in Indiana, the objectives being to develop new varieties immune to apple scab, and to investigate disease resistance and the inheritance of horticultural characters in the apple. In 1948 the agreement was extended to include the New Jersey Agricultural Experiment Station.

Methods of Operation

The original small-fruited but scab-resistant forms were crossed with the best commercial apple varieties in 1944 through 1946. The resulting seeds were germinated in the greenhouse and the seedlings inoculated with the fungus causing apple scab. All susceptible seedlings were discarded.

The remaining seedlings, usually comprising half or more of the original number, were planted in the field and grown to fruiting. The first progenies, consisting of some 2,000 seedlings, began to fruit in 1950, and several hundred new seedlings have come into bearing each year since. Selections have been made from these seedlings on the basis of fruit size, color, quality, and other horticultural characters.

Effects of uncontrolled apple scab on fruits of Rome Beauty. (Fig. 1)

Each year trees selected during the previous season have been crossed with commercial varieties, and further selections have been made on the bases described above.

Some 25 scab-immune species and varieties of crabapples have been discovered and used as original breeding parents. The program is thus being advanced in several major lines of breeding, each line being based on one of the original sources of scab immunity. These lines will eventually be combined into one or a few, thus combining the resistance from several different sources.

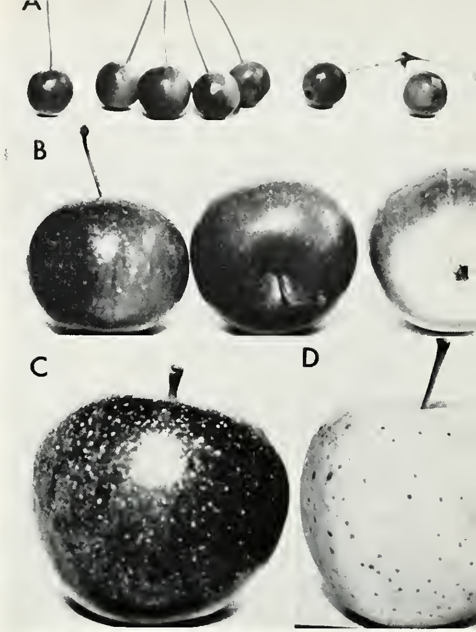
Malus Floribunda Line

At present the most advanced line of breeding is that derived from *Malus floribunda.* This ornamental crabapple, which was introduced into the United States from the Orient in the mid-nineteenth century, bears yellow, inedible fruits about ½ inch in diameter. *M. floribunda* is immune to apple scab in the field, and it transmits immunity to 50 percent of its seedlings.

The late Professor C. S. Crandall had used this species in his apple-breeding work, and by 1943 a group of seedling trees of *M. floribunda* parentage were fruiting in the station orchards. A number of individual trees in this group were found to be free of the disease in the field, and shortly thereafter these and the original *M. floribunda* parent were found to be immune on the basis of greenhouse tests.

Two seedlings with red fruits 1½ and 2 inches in diameter, respectively, were selected for use as immune parents, and were crossed with

Resistant seedlings can be quickly separated from susceptible ones after greenhouse inoculations with *Venturia inaequalis*, the fungus causing apple scab. Susceptible seedlings are killed by the disease at this early stage of growth. (Fig. 2)



Fruits of ***Malus floribunda*** are shown in row "A" at right. The apples in the other two rows represent some results of crossing this oriental crabapple with commercial varieties: B — Selection 26829-2-2. Each parent was a cross of ***M. floribunda*** and Rome Beauty. C — Fruit of 47-77, which was developed by crossing 26829-2-2 with Jonathan. D — Fruit of 14-145, which is a cross of 26829-2-2 and Golden Delicious. (Fig. 3)

the best commercial varieties such as Jonathan and Golden Delicious. About 800 scab-immune seedlings from these crosses were planted for fruiting tests, and from this group several individual trees were selected with fruit closely approaching commercial size and color, although fruit quality was still too low to be commercially acceptable.

Over 30 selections were again crossed with a wide range of commercial varieties, resulting in a number of very promising progenies comprising nearly 5,000 seedlings. Only a very small fraction of these has fruited thus far; 5 or 6 more years are necessary to evaluate most of the trees. The chances of obtaining commercially desirable varieties from this group appear excellent.

Russian Seedling Used

Another line of breeding which has been advanced very rapidly is that derived from the Russian seedling R12740-A. This is a selection from a group of trees raised from seed that the Leningrad Botanical Gardens sent to the Illinois Station in 1936. The tree selected is very vigorous, hardy, productive, and immune to apple scab. It has transmitted the immunity to over 80 percent of its progeny. Its fruit is about 2 inches in diameter, greenish-yellow, and extremely acid.

In 1947 R12740-7A was crossed with several commercial varieties, including Wealthy and Delicious. About 1,200 seedlings from the first crosses were fruited, and some 50 were selected and used as immune parents in further crosses. Nearly 9,000 seedling trees were raised and still are in the process of evaluation and selection, although nearly 7,000 have already fruited.

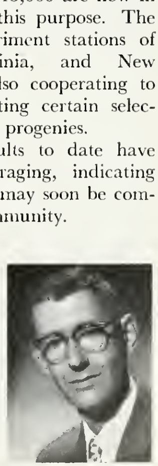
Over 1,000 individuals representing a very wide range of horticultural types have been selected and backcrossed with commercial varieties. Most of these selections still do not have high enough dessert quality for commercial acceptance, but one has the best quality that the writer has encountered at its season of maturity — about August 25 at Urbana. Several more years of testing are necessary before a decision can be reached regarding the value of this selection to the industry.

Large Number of Seedlings Has Been Tested

Since the start of the program, the three cooperating stations have produced over 150,000 seedlings by controlled cross-pollination and have tested them in the greenhouse for immunity to apple scab. Nearly 12,000 trees have been grown for fruiting tests and another 15,000 are now in the orchards for this purpose. The agricultural experiment stations of Wisconsin, Virginia, and New Hampshire are also cooperating to the extent of testing certain selections and seedling progenies.

All in all, results to date have been very encouraging, indicating that good quality may soon be combined with scab immunity.

D. F. Dayton, Assistant Professor of Plant Breeding in the Department of Horticulture, does both teaching and research. He came to the University of Illinois from the University of New Hampshire in 1950.



Growth of CROSSBRED and PUREBRED DAIRY HEIFERS

R. W. Touchberry (left), Associate Professor of Genetics in the Department of Dairy Science, inspects a purebred Holstein, a crossbred, and a purebred Guernsey produced in the crossbreeding project.

R. W. TOUCHBERRY

CROSSING Holstein-Friesians and Guernseys has been a project of the Illinois Agricultural Experiment Station since 1949. The Dairy Husbandry Research Branch of the U. S. Department of Agriculture is cooperating in the work.

Objectives are to measure the effects of crossbreeding on milk and butterfat production, on milk composition, and on body weights and measurements. Holsteins and Guernseys are being used because one yields a large quantity of milk with a relatively low test, while the other yields a comparatively low amount with a high test.

The Cattle

In the summer of 1949, 20 open Guernsey and 20 open Holstein heifers were obtained from herds on test throughout Illinois. A proven sire of each breed was then chosen.

The relationship among animals of the same breed was very small. This was also true of replacements obtained later. Thus, purebreds born in the project were not inbred.

The Mating System

Both purebreds of each breed and reciprocal crossbreds were produced every year, so that the comparison of crossbreds with purebreds was not confounded with year, sire, or breed of dam.

For the first matings random samples of ten Holstein heifers and ten Guernsey heifers were mated to the Guernsey sire and the remaining ten of each breed were mated to the Holstein sire. The second year the heifers that were first mated to the Guernsey sire were mated to the Holstein sire and vice versa.

For the third and fourth years, a second pair of proven bulls was obtained, cows that had to be culled were replaced, and the same mating system was followed. A third pair of bulls was obtained for the fifth and sixth years, and again the same mating plan was repeated.

Feeding and Management

In general, the animals received slightly more feed than called for by Morrison's standards. Each animal thus had ample opportunity to express its genetic potential.

Heifers were kept in individual pens until they no longer received milk (about 3 months of age). They were then kept in four loose housing groups according to their ages (3-6 months, 6-10 months, 10-15 months, 15 months to calving). After calving they were housed in a stanchion barn.

Measurements Taken

Animals were weighed and measured at 3, 6, 12, 18, 24, 30, 36, 48, and 60 months of age. The measurements taken were circumference of chest, circumference of paunch, depth of chest, height at withers, and length from the point of withers to pins. Every measurement was made three times on each animal at each age, and results were averaged.

Table 1. — Numbers of Female Progeny on Which Measurements Were Made

Progeny group[a]	Age in months 3	6	12	18	24	30	36	48
HH	23	27	27	27	27	26	19	13
GH	19	23	23	23	23	22	20	17
HG	19	21	21	21	21	19	16	10
GG	11	16	16	16	16	16	14	10
Total	72	87	87	87	87	83	69	50

[a] HH — Purebred Holstein. GH — Crossbred from Guernsey sire and Holstein dam. HG — Crossbred from Holstein sire and Guernsey dam. GG — Purebred Guernsey.

Body weight, chest girth, and paunch girth are considered measures of fleshiness, while height at withers, body length, and chest depth are measures of skeletal development. Only the data on body weight and height at withers up to 48 months of age are included in this study.

At all ages the mean weights followed the same order, with purebred Guernseys (GG) being smallest, crossbreds by Holstein sires out of Guernsey dams (HG) second, crossbreds by Guernsey sires out of Holstein dams (GH) third, and purebred Holsteins (HH) largest (Table 2). Means for height at withers followed this pattern, too, except that at 3 months the crossbreds (GH) were slightly larger than the purebred Holsteins.

Effect of System of Mating

The data were analyzed to determine the effects of system of mating, as well as breed of sire and breed of dam. The effects of mating system are the differences between the mean weights and heights of crossbreds and those of purebreds.

Although crossbreds were consistently larger than the purebreds in height, the general effect of mating system on skeletal growth was too small to be of either practical or statistical significance (Table 3).

The effects of mating system on body weight, the measure of fleshiness, were somewhat different. Crossbreds were considerably larger than the purebreds at all ages. Differences were large enough to be significant, however, only at 18 and 24 months.

Effect of Breed of Dam and Sire

The effect of breed of sire is the difference between the mean of progeny by Holstein sires and the mean of progeny by Guernsey sires. Similarly, the effect of breed of dam is the difference between the means of progenies out of Holstein and out of Guernsey dams.

Differences associated with breed of dam were large and highly significant at all ages for both weight and height (Table 3). Differences associated with breed of sire were in general significant after about 12 months of age.

It would be expected that, after about 6 months of age, differences due to breed of sire would about equal those associated with breed of dam. However, the differences associated with breed of dam were without exception larger than those associated with breed of sire, and were usually about twice as large. The effect of breed of dam on birth weight was about 3 times that of breed of sire — 19.3 pounds compared with 6.3 pounds.

Three possible explanations of the inequality between the effects of breed of dam and breed of sire are suggested. First, it could be attributed to cytoplasmic inheritance. This has not been conclusively shown to exist in higher animals and, further, would be unlikely to have a marked effect on a quantitative characteristic.

Secondly, the inequality might be explained if the Holstein sires transmitted smaller size than the Holstein dams or the Guernsey sires transmitted larger size than the Guernsey dams, or if both conditions existed. However, the foundation dams and their purebred progeny were of normal height and weight for their breeds. This suggests that sires and dams must have transmitted approximately normal size.

A third possible explanation is that the prenatal environment provided by the larger Holstein dams permitted more growth during the fetal stage. This may reasonably explain differences observed at the younger ages, but it is a questionable explanation of the later differences. If reciprocal crossbreds are assumed to have essentially the same genetic makeup, then the crossbreds from Guernsey dams might be expected to eventually be as large as those from Holstein dams. However, as shown in Table 2, a difference still existed at 48 months.

Some Points to Consider

The differences between the reciprocal crossbreds should be considered when the crossing of two breeds quite different in size is contemplated. There appears to be some advantage in letting the dams be of the larger breed.

Obviously, an increased rate of growth in fleshiness is not as important in dairy animals as in animals grown primarily for meat. However, more rapidly growing heifers can generally be bred younger, thus shortening the period of feeding and caring for a non-producing young animal and also slightly shortening the long generation interval of dairy cattle. Furthermore, the more rapid and probably more efficient growth at younger ages might make it more feasible to fatten dairy bull calves and cull heifers for market.

It must be remembered, however, that the end result of crossbreeding is largely determined by the size of the breeds. While crossbreeding might change size considerably in any one generation, further changes would depend on selection for size. It is likely that a breeder primarily interested in larger or smaller cattle would in the long run make more progress by selecting for size rather than by crossbreeding.

Table 2. — Mean Weights and Heights of Progeny Groups

Measurement	Progeny group[a]	Age in months							
		3	6	12	18	24	30	36	48
Body weight (lb.)	HH	220	387	693	951	1,166	1,236	1,273	1,408
	GH	211	365	661	908	1,123	1,163	1,237	1,331
	HG	191	337	621	832	1,034	1,109	1,091	1,198
	GG	155	305	535	700	889	955	995	1,055
Wither height (cm.)	HH	88	102	118	127	133	135	136	138
	GH	89	101	117	125	130	133	133	134
	HG	85	98	114	122	127	129	130	131
	GG	83	97	111	119	123	126	125	126

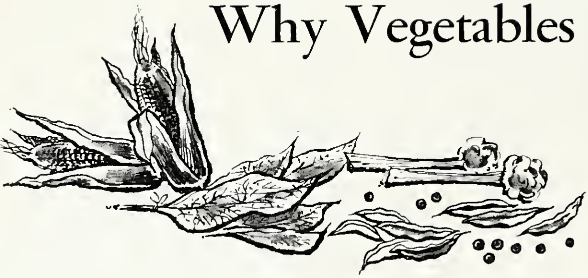
[a] See footnote a, Table 1.

Table 3. — Differences in Weights and Heights Due to Breeds of Sire and Dam and to System of Mating

Measurement	Effect[a]	Age in months							
		3	6	12	18	24	30	36	48
Body weight (lb.)	Br. S.	22.0*	26.8*	58.6*	87.4*	93.6*	114.0*	65.8*	109.8*
	Br. D.	42.6*	55.2*	99.0*	163.4*	183.4*	167.2*	212.4*	243.2*
	S. M.	13.6	4.6	27.2	45.2*	51.2*	40.4	29.8	33.4
	S. E.	6.8	8.8	15.4	14.8	17.0	29.2	25.8	35.6
Wither height (cm.)	Br. S.	0.4	1.1	2.3*	2.2*	2.9*	2.9*	3.7*	4.6*
	Br. D.	4.3*	3.7*	4.8*	5.8*	6.5*	6.7*	7.3*	8.3*
	S. M.	1.4	−0.1	0.4	0.6	0.2	0.3	0.6	0.3
	S. E.	0.7	0.6	0.7	0.6	0.6	0.6	0.7	0.8

[a] Br. S. — Difference between the means of the progeny of Holstein sires and the progeny of Guernsey sires. Br. D. — Difference between the means of the progeny of Holstein dams and the progeny of Guernsey dams. S. M. — Difference between the means of crossbred and purebred progeny. S. E. — Standard errors of the differences.

* Significant at the 0.01 level of probability.



Why Vegetables Should Be Blanched Before Freezing

FRANCES O. VAN DUYNE and VIRGINIA R. CHARLES

THE NECESSITY FOR BLANCHING or scalding vegetables before freezing was first reported in the scientific literature 30 years ago. Since then many investigators have shown that blanching inactivates enzymes which would otherwise cause unnatural colors and disagreeable flavors and odors to develop during freezer storage.

The statement is still frequently heard, however, that vegetables prepared for freezing under home conditions but without blanching maintain good quality. Because the Department of Home Economics has an active research project on "Methods of Home Freezing," it seemed important to obtain a clearer picture of what actually happens when blanched and unblanched vegetables from the same lots are frozen.

Five Vegetables Studied

Several lots of freshly harvested broccoli, corn, peas, snap beans, and spinach of known variety and optimum maturity for freezing were obtained from the Department of Horticulture. Each lot was processed in the food research laboratory the same morning it was received. For part of every lot, the preliminary preparation, blanching, cooling, packaging, freezing, and freezer storage were carried out according to the directions given in Illinois Circular 602, "How to Prepare Fruits and Vegetables for Freezing." The rest of each lot was packaged and frozen without blanching. Enough samples of blanched and unblanched vegetables were frozen to provide material for testing after several intervals of freezer storage.

In this study we were interested in the retention of ascorbic acid and in palatability. Ascorbic acid was determined by a chemical method, while palatability was rated by a taste panel usually consisting of three or four members of the food research staff.

Retention of Vitamin C

How blanched and unblanched broccoli, peas, and snap beans compared in retention of ascorbic acid during freezer storage is shown in the table on page 11. Ascorbic acid contents of the various samples are given in milligrams per gram of vegetable; and are also expressed as percentages of the amounts that were present in the freshly harvested vegetables.

Except for broccoli that had been stored 1 month, all the samples that had been frozen after blanching and cooling contained more ascorbic acid than did the samples frozen without blanching. Differences were significant after the following intervals of freezer storage: broccoli — 6 and 9 months; peas — 3, 6, and 9 months; and snap beans — 1, 3, 6, and 9 months.

In another series of experiments the ascorbic acid contents of blanched and unblanched snap beans were determined after 2 weeks, 4 months, and 8 months of freezer storage; and of blanched and unblanched spinach after 2 weeks, 5 months, and 8 months. Even after 2 weeks the blanched and unblanched samples differed in the amounts of vitamin C retained. Percent retentions were 79 and 62 for the blanched and unblanched snap beans, and 52 and 28 for the blanched and unblanched spinach. After 8 months of freezer storage the unblanched spinach contained only 1 percent of the original amount of ascorbic acid.

Palatability

The palatability factors scored were appearance, color, texture, flavor, absence of off-flavor, and general acceptability. A score of 5 means the characteristic was considered very good; 4, good; 3, fair; 2, poor; and 1, very poor.

Mean scores for general acceptability of blanched and unblanched broccoli, peas, and snap beans cooked and rated after 1, 3, 6, and 9 months of freezer storage are presented in the graph on page 11.

During the entire 9 months, scores of blanched samples were 4.0 to 4.4, corresponding to ratings of good to high good. After cooking,

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the blanched vegetables were bright green and tender, and had a good flavor. No off-flavors were noted.

On the other hand, unblanched samples that had been stored for only 1 month received mean general acceptability scores of 2.4 to 2.9, corresponding to ratings between poor and fair. Mean scores for color, flavor, and absence of off-flavors were significantly lower in unblanched vegetables than in blanched ones. Strong off-flavors developed and unblanched products lost color during the first month in the freezer.

After 3 months of storage, frozen unblanched peas were faded in color, while snap beans were slightly gray. Broccoli was rather tough in texture and strong in flavor.

Further deterioration occurred in unblanched products stored 6 and 9 months — so much, in fact, that the vegetables were considered inedible. In color, broccoli and snap beans were uneven, dull, and gray. The skins of peas were tough, and the stems of broccoli, fibrous. Flavors were extremely objectionable, rating between very poor and poor. Off-flavors, which were described as hay-like, were intense. Broccoli, especially, had a strong hay-like flavor.

The palatability of frozen blanched and unblanched corn was also studied. Corn of the same variety was obtained on 5 successive days, and a portion of each lot was husked, the ears were washed and packaged, and the packages placed in the freezer within 1 hour of harvest. Another portion of the corn was blanched and cooled, cut off the cob, and packaged and frozen.

After 3, 6, and 9 months of freezer storage, the blanched corn rated between good and very good, while none of the unblanched was considered even fair. In general, the appearance and color of the unblanched corn were good, but the flavor was very disagreeable and there was deterioration in texture.

Blanching Recommended

Vegetables must be adequately blanched before freezing, both to keep them palatable and to retain the largest possible amounts of ascorbic acid.

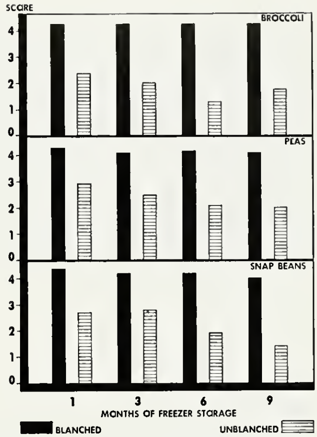
Another advantage of blanching is that it softens the vegetables somewhat, so that they are more easily and solidly packed into freezer containers than are unblanched vegetables.

Work in Progress

This summer, work on the home economics project, "Methods of Home Freezing," is following several lines. Promising new varieties of fruits and vegetables are being obtained with the advice and help of the Department of Horticulture and prepared for freezing in the food research laboratory. The palatability of these products will be rated after several intervals of freezer storage so that conclusions can be drawn about the suitability of these varieties for freezing.

The effects of variations in blanching procedures and of two temperatures of freezer storage (−10°F. and −40°F.) on the quality of frozen vegetables is also being investigated. Studies are continuing on the use of different amounts of sugar, various concentrations of sugar sirup, and a few sugar substitutes in the preparation of fruits.

An investigation of the volume, compressibility, and palatability of chocolate cakes baked before and after freezing has been planned. And the time remaining, after the experiments are finished and the results are recorded and summarized, will be spent in rewriting Illinois Circular 618, "Freezing Cooked and Prepared Foods." Since there is quite a little more material to add to this circular, we are anxious to get it ready for printing.



General acceptability scores of vegetables frozen blanched and unblanched.

Ascorbic Acid Content of Vegetables Frozen Blanched and Unblanched

Vegetable	Months of freezer storage	Vegetables frozen blanched: Ascorbic acid content[a]	Vegetables frozen blanched: Retention on raw weight basis	Vegetables frozen unblanched: Ascorbic acid content[a]	Vegetables frozen unblanched: Retention on raw weight basis
		mg./gm.	percent	mg./gm.	percent
Broccoli	1	.68 ± .032	66	.70 ± .045	66
	3	.67 ± .024	64	.62 ± .029	57
	6	.64 ± .022*	60	.43 ± .039	40
	9	.57 ± .014*	54	.38 ± .024	36
Peas	1	.22 ± .008	70	.18 ± .015	63
	3	.24 ± .007*	75	.16 ± .007	55
	6	.22 ± .008*	71	.11 ± .005	36
	9	.22 ± .010*	70	.11 ± .007	37
Snap beans	1	.13 ± .004*	85	.08 ± .007	58
	3	.12 ± .008*	83	.06 ± .009	44
	6	.10 ± .011*	64	.02 ± .005	15
	9	.06 ± .007*	43	<.01 ± .003	3

[a] Mean values for 4 replications and standard deviations of the means.
* Indicates significantly higher mean values for the blanched samples than for corresponding unblanched ones.

Does Pasture Rotation Control SHEEP PARASITES?

NORMAN D. LEVINE

Sheep may have over a dozen different species of roundworms in their stomachs and intestines. The most important in Illinois is the barberpole stomach worm, *Haemonchus contortus,* which sucks blood and can cause severe anemia in lambs — even death, if enough worms are present.

As a group, stomach worms are responsible for more sheep losses in Illinois — not only deaths but also poor weight gains — than any other disease or parasite.

Life Cycle

In order to control a parasite, we must first learn how it lives and how it is transmitted — we must know its life cycle. The barberpole stomach worm, for example, lives in the fourth stomach or abomasum, where it sucks blood. Each female lays 5,000 to 6,000 eggs a day. These are microscopic — only about 74 microns (1/340 inch) long. They pass out in the droppings and hatch on the ground.

The young worms or larvae which hatch from the eggs develop to the infective stage in 2½ days to a week or more, depending on the temperature. The warmer it is, the faster they develop — within limits, of course. They don't develop above 98° F. or below 58° F. When they reach the infective stage, they are about 700 microns (1/36 inch) long, but are so slender that they are practically invisible to the naked eye. They crawl up onto the grass and are eaten by the sheep in grazing.

Once in the sheep, they lie up against the abomasum wall, where they commence to feed and grow. Soon they attach themselves to the wall of the abomasum and begin to suck blood. They reach the adult stage and start to lay eggs in about 3 or 4 weeks, at which time the females are about 1 inch and the males about ⅔ inch long.

Other stomach and intestinal worms have similar life cycles, but they do not all suck blood.

As Professor of Veterinary Parasitology and Veterinary Research, Norman D. Levine teaches in the College of Veterinary Medicine, and does research in the Agricultural Experiment Station. He came to the University of Illinois 22 years ago.

Annual Cycle in the Sheep Flock

Infections with stomach and intestinal worms follow a regular annual cycle in the sheep flock. This cycle depends on the climate and weather, so our first task was to determine what it is in Illinois. This we did in studies carried out both at Urbana with the cooperation of Dr. U. S. Garrigus of the Sheep Division, and at Dixon Springs with Dr. M. E. Mansfield.

In Illinois, the larvae of most stomach and intestinal worms are unable to survive the winter on pasture, so they are carried over from one year to the next in the sheep themselves. During the winter, there are rarely enough worms in the ewes to cause any harm, but there are still enough to seed the pasture. A hundred barberpole stomach worms, for example, won't hurt a ewe appreciably, but the 50 females among them lay 300,000 eggs a day, and these develop into larvae which the lambs can pick up. Most of the other stomach and intestinal worms don't lay as many eggs as *Haemonchus,* but they still lay plenty.

Not only that, but there is often a so-called spring rise in the number of eggs put out by the ewes. We aren't sure what causes it, but the stress of lambing and lactation is probably involved. Moreover, some larvae seem to stay in the ewes all winter in a state of arrested development, maturing in the spring.

The lambs become infected by grazing on pasture which has been contaminated by their mothers. The ewes are by now relatively immune as the result of their earlier infections, so they rarely show symptoms unless stress, poor nutrition, or starvation weakens them and destroys their resistance. The lambs, however, have little immunity, and can sicken and die on the same pastures where their mothers remain healthy.

In central Illinois, where the pasture is usually ready for sheep about May 1, the lambs usually don't start passing stomach worm eggs until late June or early July, although larvae and immature adults may be present and causing damage. The worms build up to a peak in August, and decrease spontaneously and rapidly in the late fall. The sheep carry relatively light infections during the winter.

Pasture Rotation Tried As Control Method

Knowing this annual cycle, what are the best lines of attack against stomach worms? One which has been recommended for many years is pasture rotation. The theory behind the recommendation is this: After the worm eggs have been passed in the droppings, it takes at least 2½ days and usually longer for infective

larvae to appear. These don't survive on the pasture indefinitely, but gradually die off as they use up their reserve food supply. Therefore, if you move the sheep to fresh pasture before the infective larvae have developed and don't put them back on the old pasture until all (or practically all) the larvae have died, then the lambs won't pick up enough parasites to harm them.

The question then arises as to what pasture rotation system to use. It has often been said that a pasture would be safe if it were rested for a month. So little information on the subject has been available, however, that in 1954 we decided to find out for ourselves.

With advice from Dr. Garrigus, we set up a pasture rotation experiment in which the ewes and their lambs were rotated through a series of six grass-legume pastures, staying on each for 1 week and leaving it empty for 5 weeks. This rotation did not prevent the lambs from becoming heavily parasitized, although it did greatly increase the pasture carrying capacity.

The next year we tried doubling the number of pastures, grazing each one for 3 or 4 days and leaving it empty for 5½ weeks. Again, however, the lambs became heavily infected with worms. Lambs under both rotation systems became infected at the same time as the control lambs.

The third year we moved the animals along every 2 days, which took them off each pasture before the infective larvae had time to develop. This didn't work, either. The lambs became heavily infected on the second time around, even though they weren't returned to the first pasture until after it had been rested for 48 days. In other words, large numbers of larvae had survived and remained infective for much longer than the month previously believed sufficient for the pasture to become safe.

It is hardly practical, if one is going to make efficient use of a pasture, to keep the animals off it much longer than 48 days. Our present conclusion, therefore, is that we haven't yet discovered a pasture rotation system which is any better than no rotation at all in preventing parasitism in lambs, although all our rotations did markedly increase pasture carrying capacity. We are still working on this problem.

Appearance of rotated and unrotated alfalfa-rye pastures on May 17, 1954. Sheep had been on the control pasture (foreground) for 28 days. Animals on the pasture in the left background had been there for a week and were ready to be transferred to the pasture on the right. (Fig. 1)

The same pastures on August 11, 114 days after start of experiment. Sheep on the unrotated pasture had been fed hay since June 14. The rotated pastures grew up when rested and lasted through the entire grazing season. (Fig. 2)

Drug Treatment

In the present state of our knowledge, control of sheep parasites must still be based in good part on treatment, although good sanitation and management are also helpful. This is not a desirable situation, since no known drug is effective against the larvae of stomach and intestinal worms, and these can cause marked damage before they become adult and can be expelled by drug treatment. Much more research is needed to develop better methods of control.

Drug treatment against stomach and intestinal roundworms of sheep can be either preventive or curative. Preventive treatment is carried out routinely, regardless of the degree of infection, since it is designed to keep egg production to a minimum and thus prevent parasite transmission.

We recommend phenothiazine for both curative and preventive treatments. Some authorities recommend alternating phenothiazine with a mixture of copper sulfate and nicotine sulfate (Cu-Nic), but this does not seem to be called for under Illinois conditions.

On the basis of our studies, we prepared a set of recommendations for controlling sheep parasites on Illinois pastures and feedlots. This is entitled "A control program for gastrointestinal nematodes of sheep," and was issued as the October, 1958, *Timely Topics* of the College of Veterinary Medicine. A copy can be obtained by writing to the College of Veterinary Medicine, University of Illinois, Urbana.

CAREERS for the Graduate in HOME ECONOMICS

MARGARET GOODYEAR

During each of the last 2 years, University placement offices have received 500 requests for young women with training in home economics. This averages about five jobs for every home economics graduate. Opportunities are not only numerous but varied. Some of the major ones are described below.

Teaching

Home economics teaching runs the gamut from nursery school to adult education. Students who are particularly interested in small children may specialize in child development and family relationships. This training prepares them for work not only in nursery schools, but also in children's hospitals, child care centers, and settlement housing.

High school and junior high teachers are in great demand. Girls preparing for this field receive training in general home economics and teaching methods. They may teach most of the phases of home economics — child and family, housing, home furnishings, home management, foods, nutrition, textiles, and clothing.

The county home adviser teaches the same subjects, but her students are homemakers and 4-H Club members. Besides meeting with organized groups, she uses press, radio, and television to present home economics information.

College teaching requires advanced study in one of the phases of home economics.

Business

Merchandising is one of the newer fields open to home economics graduates. It is for those interested in either home furnishings or clothing and textiles.

Many large retail stores have executive training programs which enable beginners to supplement their college education with "on-the-job" experience. Such training may lead to a career as fashion coordinator, interior decorating consultant, head of stock, or buyer; or to some other managerial position.

Other kinds of business employ home economists to work with consumers in various ways. The home service director of a utility company, for example, renders personal service to customers. Similarly, pattern companies and fabric manufacturers often have need for educational directors; and foods companies hire home economists as demonstrators.

As brought out in the following paragraphs, the business world also offers opportunities to home economists who are interested in research or in journalism.

Research

A well-trained home economist with a strong scientific background has opportunities to do research in government, university, and business laboratories. Product testing, for example, is a wide-open field for women with the proper qualifications. This may include perfecting new food items, working with new fabrics or fibers, or testing new household appliances.

Advertising and Journalism

Many advertising jobs require home economists who have ability in writing or some other form of communication. Food processing companies, for example, need young women to present radio and television programs, prepare food for photography, and write information for advertising booklets.

Newspapers, magazines, and radio and television stations offer other opportunities.

Quantity Foods

The number of dietitians needed to help feed the public continues to increase, as more and more meals are eaten away from home. Both men and women can find stimulating employment in restaurants, hotels, and school and industrial cafeterias, where they are responsible for planning and supervising the purchase, preparation, and serving of food in large quantities.

Hospital dietetics offers a career for the student with a strong background in nutrition, quantity foods, and chemistry. The dietitian works with doctors, nurses, and patients in planning diets that help restore health to those who are ill.

Homemaking

About 50 percent of the seniors in 1957 and 1958 were married either before or right after graduation. Of these, at least half accepted employment. This is in line with the growing trend for women to work outside the home before they have a family and after the children are grown.

The Department of Home Economics offers training for responsibilities both within and outside the home. The modern homemaker calls upon her knowledge in all areas of homemaking. For this reason, beginning "core" courses in the department include the study of every phase of home economics. Specialization during the last two years of college prepares a graduate for a career outside the home.

Placement of Graduates

The home economics placement office keeps a file of positions open, and a list of companies and other employers who frequently need home economists. Information about openings is gained through correspondence with employers, campus recruiting by company representatives, contacts of faculty members, and visits to personnel offices of the various companies.

Margaret Goodyear, Associate Professor of Home Economics, is in charge of the department's placement service.

RESEARCH IN BRIEF

Experiments Measure Effects of Lodging on Yield and Quality of Small Grains

The improved lodging resistance bred into the small grain varieties released in recent years has probably contributed much to the rising average yields of Illinois small grain crops.

That lodging greatly reduces both yield and quality of grain is emphasized by recent experiments in the Department of Agronomy. Spring oats were artificially lodged in 2 years; and winter wheat, 1 year. A 2-inch mesh wire was stretched about 18 inches above the ground, and the plants were permitted to grow through the wire. On a selected lodging date, the wire was gently moved in a horizontal direction and refastened when the desired degree of lodging had been reached.

Results of the experiments are summarized in the tables. The earlier the lodging, and the greater the degree of lodging, the larger was the reduction in yield and test weight.

These plots were hand-harvested. If a combine had been used, the differences would probably have been greater, since weak-strawed varieties are difficult to combine and the machinery misses some of the grain. It appears from these tests, however, that the unseen grain loss due to lodging may equal or even exceed the obvious loss of harvesting.

These studies help to explain how the time or the degree of lodging can cause oat varieties that differ in maturity to rank differently in yield and test weight from one year to the next or even in different tests the same year. A farmer may plant a variety that has a good performance record and yet, because of lodging caused by thunderstorms, be very disappointed in yield and test weight at harvest. — *J. W. Pendleton and R. O. Weibel*

Table 1. — Yield and Test Weight of Spring Oats Artificially Lodged (2-Year Average)

Lodging treatment	Yield		Test weight	
	bu./A.	perct.[a]	lb./bu.	perct.[a]
Erect, no lodging	68.2	100	27.0	100
Lodged 90°, 4 days after heading	43.1	63	21.4	79
Lodged 45°, 4 days after heading	58.8	86	25.6	95
Lodged 90°, 20 days after heading (hard dough stage)	56.3	83	25.7	95
Lodged 45°, 20 days after heading	66.1	97	26.4	98

[a] Plants that were not lodged are considered 100 percent.

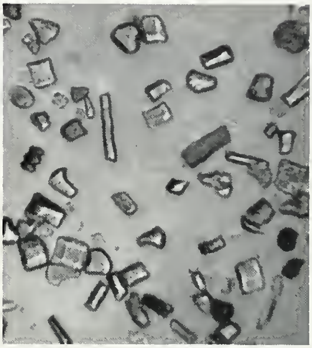
Table 2. — Yield and Test Weight of Winter Wheat Artificially Lodged,[a] 1958

Lodging date	Grain stage	Yield		Test weight	
		bu./A.[b]	perct.	lb./bu.	perct.[b]
Erect, no lodging		62.7	100	61.3	100
June 3	Milk	44.2	70	56.6	92
June 10	Soft dough	47.9	76	56.5	92
June 17	Medium dough	49.8	79	58.8	96
June 24	Hard dough	56.5	90	60.9	99

[a] All lodging was 90 percent.
[b] Plants that were not lodged are considered 100 percent.

Plants Manufacture Opal

The Department of Agronomy has discovered that the surface horizons of most Illinois soils contain a silicate mineral called plant opal. Each grain of the opal has the characteristic size and shape of plant cells. Recently it has been shown that the mineral originated from plants that grew on the soils.



Grains of opal (magnified 50 times) separated from the A horizon of Cisne silt loam.

Plants, particularly grasses, take up large quantities of silica, which are stored in the plant cells. When the plants die, the silica becomes hard, and on plant decomposition, the opal remains as a stable mineral and becomes part of the soil. The opal particles, recently named plant opal, are made up principally of silica and oxygen, but they also contain small amounts of various plant food elements such as potassium and phosphorus.

The chief importance of plant opal lies in its potential value as an index mineral. It can be used to measure such things as the encroachment of forest on grassland areas, or to characterize the vegetative cover of old buried soils. — *A. H. Beavers*

High Temperatures Affect Gain of Chickens

The effect of hot weather on the feed requirements and gain of 6-week-old chickens has been tested in the Division of Animal Nutrition. The experiments were undertaken

because reports of work done elsewhere indicated that high environmental temperatures increase an animal's requirements for protein, lysine, and certain other nutrients.

Chickens in an environment of 90° F. ate less and gained less than chickens in a 72° F. environment. However, the high temperature had no effect on protein or lysine requirement. When feed intake was equalized by reducing the amount fed to the chickens at 72° F., the birds at 90° F. outgained the others in terms of body weight and nitrogen balance.

Several attempts were made to increase the voluntary feed intake of birds at 90° F. Insulin injections did stimulate appetite for a while, but the use of other agents was unsuccessful. — *J. Kastelic*

Treat Your Fence Posts to Longer Life

Keeping fences in good repair is a perennial problem for many farmers. Most of the trouble results from fungi and insects that attack the wood and cause the posts to fail. Replacing the posts is costly in both time and labor.

A solution to the problem, of course, would be to use wood that resists decay and insects. Some woods such as osageorange (hedge) or black locust have a natural resistance, and often last 20 years or more under severe service conditions.

These two black oak posts were placed in the ground in 1942. The one on the left was cold-soaked in pentachlorophenol for 48 hours and shows no sign of decay after 16 years of service. The untreated one (right) failed after less than 5 years.

Unfortunately, in many areas of Illinois the supply of durable species is getting scarcer and the nondurable species must be used. If these less durable woods are given proper preservative treatment, however, they can be expected to last as long as the naturally durable ones.

In the summer of 1942, the Department of Forestry began testing treated fence posts at the Dixon Springs Experiment Station, Pope county, and at Sinnissippi Forest, Ogle county. Since that time, 1,353 treated posts have been in test under actual service conditions. They represent 19 species of hardwoods and 5 of softwoods. In addition, 192 untreated control posts have been tested. Most of the original untreated posts have been replaced because of failure.

The bark was peeled off and the posts were seasoned before being treated in the round condition. Several commercial wood preservatives were employed, and the methods used included brushing, dipping, and soaking. On the basis of 16 years' research, cold-soaking in a pentachlorophenol — fuel-oil solution for 48 hours seems the best method for use on the farm.

The benefits of the "home-type" treatment given the nondurable posts are shown below:

Sound posts	*Number*	*Percent*
Treated	681	50
Untreated	2	1
Total	683	..
Decayed posts		
Treated	584	43
Untreated	53	28
Total	637	..
Failed		
Treated	88	7
Untreated	137	71
Total	225	..
All posts		
Treated	1,353	88
Untreated	192	12
Total	1,545	..

Average service age of the treated posts, up to the fall of 1958, was 12 years. Average service life of the untreated posts that had failed was less than 5 years. — *K. R. Peterson*

Vitamin E Deficiency Not Usual in Swine

Swine do not easily develop symptoms of vitamin E deficiency. In experiments by the Division of Animal Nutrition, symptoms were produced only by feeding a vitamin E-free diet to which cod liver oil (equal to 10 percent of the dry weight of the diet) had been added. This diet was fed to baby pigs from 3 days to 8 weeks of age.

Deficiency symptoms included liver necrosis, yellow fat, and degeneration of skeletal and heart muscle. Some animals died. Other affected animals quickly recovered, however, when vitamin E was added to the diet.

These findings emphasize that swine are not likely to be affected by vitamin E deficiency under ordinary circumstances. However, when symptoms do occur, they are similar to those in other animals. — *J. Kastelic*

Moisture Used by Pine Trees in Southern Illinois

A shortage of soil moisture at some time during the growing season is the rule and not the exception in Illinois. Both farm and forest management should be designed with this knowledge.

Moisture reaches the earth in such familiar visible forms as rain and snow. It returns to the atmosphere as invisible vapor, either by direct evaporation or the transpiration of living plants. Collectively this is called "evapotranspiration." Drouths occur when the moisture lost from the soil by evapotranspiration is not replaced by precipitation.

Evapotranspiration has been measured since 1951 in shortleaf pine plantations at the Dixon Springs Experiment Station in southern Illinois. There were sharp contrasts in the amounts of available moisture during the 1951 and 1952 growing seasons. Rainfall was above normal in 1951, except during May and July. June was very wet. Temperatures were near the average for the period. The

following year, 1952, was the first of three drouth years. Rainfall was deficient from April through November. June and July temperatures approached all-time highs.

Following is a month-by-month accounting of moisture for the two growing seasons:

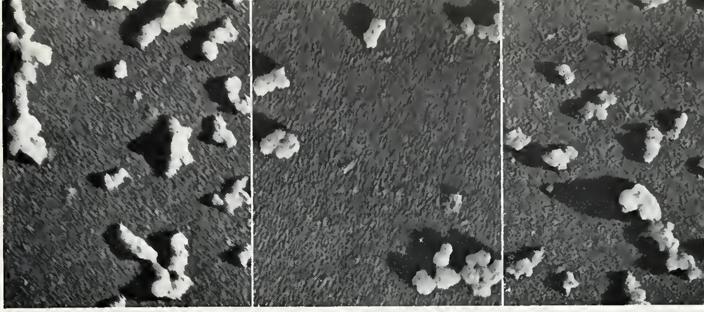
Year and month	*Moisture in soil*[a]	*Loss or gain*[b] (*inches*)	*Rainfall*	*Moisture used*
1951				
Apr.	7.00	−1.00	3.80	4.80
May	6.00	− .30	2.00	2.30
June	5.70	+1.39	8.87	7.48
July	7.09	−5.20	1.05	6.25
Aug.	1.89	− .03	3.62	3.65
Sept.	1.86	− .79	4.64	5.43
Oct.	1.07	− .16	1.84	1.69
1952				
Apr.	7.32	−2.13	2.84	4.97
May	5.19	− .37	3.77	4.04
June	4.92	−4.64	1.87	6.51
July	.28	− .28	1.65	1.93
Aug.	0	+ .44	1.08	.64
Sept.	.44	− .44	3.21	3.65
Oct.	0	0	1.11	1.11

[a] Inches of moisture stored in soil on first day of month.
[b] Inches change in moisture storage during month.

Evapotranspiration losses were about 30 inches in 1951 and 21 inches in 1952. They clearly reflect the amounts of available moisture. The severity of the 1952 drouth may be recognized by noting that the available moisture in the soil was exhausted by the first of July.

By contrast, the heavy June rains in 1951 somewhat increased the moisture stored in the soil. This gain quickly disappeared in July, when rainfall was light, and the available soil moisture was essentially exhausted. After this, rainfall kept pace with evapotranspiration well into October.

Extreme drouth, such as that of 1952, is not the general rule in Illinois. The depletion of soil moisture that occurred in 1951 is typical of all except the extremely wet years. There was probably little visible drouth damage in 1951. However, even in this year of above-average rainfall, plants probably did not attain maximum growth during midseason, since the supply of moisture was less than the demand. — *W. R. Boggess*



Particles from elm phloem necrosis (left); peach X-disease (center); cherry ring spot (right). Discovery of these particles will help in diagnosing infected trees.

Field Terraces Studied

Since terraces are the most effective mechanical practice for controlling erosion, ways to make them more acceptable to farmers are being studied. Cooperating in the project are the Department of Agricultural Engineering of the University of Illinois, and the Agricultural Research Service, U. S. Department of Agriculture. Both terrace size and shape and field machine operations are being considered.

The effect of straight-row field operations on terrace capacity has been studied since 1950. Most of the study has been conducted at the Elwood Experimental Field in northeastern Illinois.

Results of the study have brought out the following facts: Although straight-row operations cause an average yearly loss of only 10 percent in terrace capacity, the terraces are more likely to be over-topped during heavy rains. This usually happens at the lower end of the terrace, where the channel may not make a smooth junction with the outlet waterway. Dropping and pulling implements out of the soil at the edge of the waterway may cause a hump there. Extra maintenance is needed to assure that the water gets into the outlet easily.

As a second phase of the study, begun in 1958, conventionally staked terraces are being compared with parallel terraces. Also, wider terrace spacings, particularly on permeable soils, are being investigated on co-operator farms in several counties of northwestern Illinois. — *B. A. Jones, Jr.*

Virus-Like Particles From Tree Viral Diseases

Some virus-like particles have recently been discovered at the Illinois Station in extracts from trees infected with elm phloem necrosis, peach X-disease, and peach or cherry ring spot. The particles were not found in extracts from healthy trees.

Although there is as yet no proof that these particles are infectious, the findings are useful in diagnosing infected trees by laboratory tests. Diagnosis by laboratory methods is often necessary because visible symptoms are not always conspicuous or may even be confused with symptoms of other infectious or noninfectious maladies of plants. Viruses that cause tree diseases have not been generally characterized or seen in the electron microscope because techniques for their study are not yet sufficiently advanced.

The newly discovered virus-like particles are similar to the known spherical viruses which infect plants. The particles from elm phloem necrosis and peach X-disease are about 0.000002 inch in diameter, and those from cherry ring spot are about 0.000003 inch. — *H. H. Thornberry*

Hardware Cloth Used for Remodeling Corn Cribs

With the present trend toward storing shelled corn on the farm, there is a great deal of interest in remodeling ear corn cribs for shelled corn storage. One of the big jobs in remodeling is to make the walls of the

crib grain-tight. Hardware cloth is one of a variety of materials that may be used.

Hardware cloth is easy to apply and is comparatively low in cost. A big question, however, is whether shelled corn will keep in a crib remodeled with this material, since the walls are not weather-tight.

The Department of Agricultural Engineering began a study of this system of crib remodeling in the fall of 1957. Two 1,000-bushel grain storage buildings were remodeled to provide the same wall construction as a crib remodeled with hardware cloth. They were filled with No. 1 yellow corn in late September.

The condition of the stored grain was carefully checked at regular intervals. There was no evidence of deterioration until late in the summer of 1958, when insects became quite numerous in the grain. Because of this problem, the grain was marketed in September, 1958. Of the 2,000 bushels, 10 could not be marketed because of heavy insect infestation and caking along the junction of the side walls and floor.

On the basis of experience to date, cribs remodeled with hardware cloth seem to offer quite safe storage from harvest until the middle of the following summer. Storage for a longer period appears somewhat risky because of insect problems.

Research work is continuing on this problem. In October, 1958, the storage structures were refilled with shelled corn that had been treated for insects. If our insect-control measures are successful, we believe

Hardware cloth being fitted between the studs of a crib.

there is a good chance that the grain will remain in condition for more than a year. — *J. O. Curtis*

Frozen Foods Keep Well Under Proper Conditions

The importance of storing frozen food at 0° F. or below has been established by research both at the University of Illinois and elsewhere.

About 10 years ago, U. S. Department of Agriculture researchers, in cooperation with frozen food industry leaders, undertook a study to determine the effects of storage temperature and storage time on the acceptability of frozen foods. This work was prompted by the fact that products were often leaving the packing plants in excellent condition, only to be seriously deteriorated by the time they were purchased at the retail level.

The changes which take place in frozen foods between the packing plant and the consumer almost invariably affect color and flavor. Usually the color fades and flavor is lost or off-flavors develop. Frozen foods which have undergone such deterioration are not harmful but they definitely lack acceptability, and many consumer complaints result.

The research done during the past 10 years has shown that storage temperatures above 0° F. cause deterioration. Some products are damaged more than others.

At the University of Illinois work is now underway on the effect of storage temperature and time on frozen sweet corn. Although the study is not complete, it is very apparent that above-zero storage temperatures adversely affect color and flavor.

Results of all this work can be profitably applied to the home freezer. The temperature in the freezer should be maintained at 0° F. or somewhat lower. The freezer should be defrosted when heavy frost or ice is formed on the refrigerated walls. Ice makes the cooling operation less efficient, and the temperature in the freezer tends to rise. Products in the freezer should be dated and not held for long periods of time. This is especially true for meat, which does not normally retain quality over long storage periods.

If these simple rules are followed, frozen foods will retain high quality in the home freezer. — *A. I. Nelson*

Fineness Important in Determining Limestone Quality

Many farmers are not giving enough attention to the quality of limestone they buy. According to recent greenhouse studies by H. L. Motto of the Department of Agronomy, much of the limestone now being used is too coarse to be effective.

Limestone quality is usually determined by its neutralizing power, or calcium carbonate equivalent (CCE); and its screen score, or fineness. By present standards, the screen score is the percent of the material that passes through an 8-mesh sieve. The calcium carbonate equivalent is the relative neutralizing power of the limestone, determined chemically and reported in percent, as compared with the neutralizing power of pure calcium carbonate. The product of these two percentage figures must exceed 72 for the material to qualify for ACP limestone payments.

While almost all agricultural limestone sold in Illinois meets this minimum requirement, the material still isn't fine enough to be fully effective. Particles of varying sizes (as measured by the mesh through which they would pass) were tested for effectiveness by greenhouse methods. If material finer than 100 mesh is considered as 100 percent, the particles have the following relative effectiveness:

Size of particles	*Relative effectiveness (percent)*
Larger than 10 mesh	9
10 to 28 mesh	15
28 to 40 mesh	41
40 to 60 mesh	58
60 to 100 mesh	78
Smaller than 100 mesh	100

As much as 95 percent of the material in an average agricultural limestone may pass through an 8-mesh sieve, but less than 30 percent may

pass through a 60-mesh sieve. This means that for all practical purposes the bulk of the material is relatively ineffective.

The larger a limestone particle, the slower its reaction rate in the soil. Reaction rates are approximately those given in the following table. These data are based on extrapolations of short-time (6-month) measurements into the time required to raise the pH of a soil from 4.9 to 7.0. The quantity of limestone added was the same for all particle sizes and was just enough to neutralize the soil acidity.

Size of particles	*Time*
Larger than 10 mesh	Infinite
10 to 28 mesh	Millions of years
28 to 40 mesh	25 years
40 to 60 mesh	2 years
60 to 100 mesh	6 months
Smaller than 100 mesh	2 months

It is apparent from these studies that the quality of most agricultural limestones could be doubled by improving their screen score — that is, grinding them to a finer mesh. — *S. W. Melsted*

Delayed Development of Anthracnose Investigated

Ripe tomatoes often develop small, sunken, water-soaked, circular spots which later become darker and more depressed. These spots are the symptoms of a disease known as anthracnose, which is especially serious on tomatoes grown for processing.

Although lesions appear only after ripening, fruits may be infected during development. The organism usually enters the fruit through the epidermis and becomes dormant in the green fruit. Possibly some substance in the unripe tomato actively inhibits the development of the anthracnose fungus; or the green fruit may not be suitable material for the fungus to act upon. The fruit may have to ripen and soften before the organism can penetrate and feed on the tissue.

Some fungi produce pectic enzymes which soften the plant tissues on which they feed. Anthracnose may be incapable of producing these enzymes and therefore have to wait until they are produced by the ripening fruit.

The Departments of Horticulture and Plant Pathology are now exploring these possibilities. Results of this research may suggest better control measures or means of developing anthracnose - resistant tomatoes. — *J. P. McCollum and M. B. Linn*

Self-Feeding Silage to Beef Cattle

Self-feeding from a horizontal silo has these advantages: It keeps down storage costs, lowers labor requirements, and reduces the urgency to mechanize feed handling. This method of handling silage, however, is not so simple as it often seems.

The University of Illinois, in cooperation with the U. S. Department of Agriculture, has studied 50 cattle-feeding operations to learn more about the problems involved, as well as the possibilities. The following recommendations are based on this study.

The silo should have a paved floor, year-round accessibility to a tractor, and plenty of slope for drainage. Making the silo part of a paved feedlot is desirable. A north-south silo open at the south end, with both sides exposed to sunlight, minimizes freezing of silage. An east-west silo open to the east is the best alternative.

Only high-quality forages, harvested at the correct stage of maturity and moisture content, should be used. Thorough packing is essential. Low-value forages high in moisture or black plastic sheets can be used as surface covers.

Crowding of cattle may reduce feed consumption. Too few cattle may not eat enough silage to prevent excessive freezing in winter or spoilage in warm weather. Three to four inches of feeding space per head is about right. Silage should be about 6 feet deep. Unless a silo that is at least 20 feet wide and contains at least 5 feet of silage can be justified, forages should be handled by some other method.

This feeding gate is suspended from the walls of the silo by a 3-inch iron pipe. The gate is easy to regulate and move. Individual partitions control the cattle, and the solid base excludes drainage and provides a barrier against hogs.

A partitioned feeding gate suspended by a pole from the walls of the silo is the most effective type of gate. A self-supported gate can be used, but it is difficult to move. An electric wire makes a suitable gate if managed carefully.

Chief jobs in self-feeding silage are moving the feeding gate, loosening silage, removing spoilage, cleaning the floor, and checking the operation. About 40 minutes of labor are needed to handle 100 head during an average day. — *R. N. Van Arsdall*

COMING EVENTS
(At Urbana unless otherwise indicated)

July 27: All-Industry Poultry Day

Aug. 9-12: Annual American Institute of Cooperation

Aug. 14-23: Illinois State Fair (Springfield)

Aug. 26-27: State Sports Festival

Sept. 4: Cattle Feeders' Day

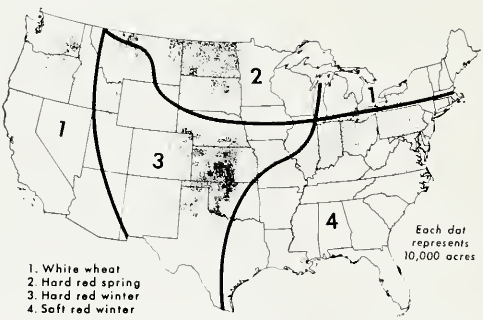
Sept. 17: Turkey Growers' Annual Fall Field Day (Clarence Zeimer Farm, Elmwood)

FARM BUSINESS TRENDS

Wheat. During the past half century, production and uses of wheat in the United States have followed quite different trends. Production increased from 684 million bushels in 1909 to 1,462 million in 1958. But the use of wheat for food in 1958-59 is estimated at only 493 million bushels, just 10 million more than in 1909-10. And the use of the 1959 crop for seed is estimated at only 66 million bushels — 4 million less than 49 years ago.

Exports rose from 89 million bushels in the 1909-10 marketing year to about 450 million in 1958-59, while addition to carryover increased from 55 million to 400 million bushels.

Estimated carryover on July 1 this year was close to 1,280 million bushels, up from 880 million last year.



There are four great wheat-producing areas in the United States. Hard red winter wheat is grown principally in the Southern Great Plains (region 3), and hard red spring wheat chiefly in the Northern Great Plains (2). These hard wheats are especially suited to making bread flours. Soft red winter wheat is produced in the eastern half of the United States (4), and white wheat predominates in the Pacific Northwest (1), with important districts also in Michigan, New York, and California. Flours from soft red and soft white wheats are used to make pastry, crackers, biscuits, and cakes. Durum wheat, grown principally in North Dakota, is used for macaroni, spaghetti, and similar products. *(From U. S. Department of Agriculture.)*

The 1959 crop may be around 1,225 million bushels — or about 150 million more than is likely to be exported and used. Thus, carryover next July could be more than 1,400 million bushels.

Corn. Stocks are at an all-time high for this time of year, but rate of use has also been very high. Total disappearance in the first half of this marketing year is estimated at 1,920 million bushels, one-fifth more than last year. This is all the more remarkable because other feeds were abundant and low in price.

Soybeans. Supply this marketing year was 595 million bushels, one-fifth more than the record supply of a year ago. Last fall it appeared that 100 million bushels might be left on hand next October 1. But during the first half of the marketing year, crushings and exports took 293 million bushels, 15 percent more than last year. It now appears likely that carryover will be about 50 million bushels at the end of this marketing year, and smaller in 1960.

Cattle. Beef output reached an all-time high of 14.5 billion pounds in 1956, then shrank to 13.3 billion pounds last year. Production may increase the last half of 1959. Farmers were feeding 8 percent more cattle on April 1 than they were a year before, and planned to market 55 percent of these after July 1. The 1959 calf crop is expected to be about 5 percent larger than in 1958. Calf slaughter was 15 to 20 percent less in the early months of this year than last year. This points to increased slaughter in 1960 and 1961.

Hogs. Production is still increasing, but not so fast as last year. Next year may bring the low in prices for this cycle. Best chance for profits is to breed early this fall for November and December farrowings. Pigs should then get to market before prices slide in the last half of 1960. — *L. H. Simerl, Professor of Agricultural Economics*

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Fall, 1959

ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

IN THIS ISSUE

Are deer spreading disease to Illinois livestock?

What gives cheese its typical flavor?

Can Christmas trees be an important crop on Illinois farms?

How much has farmers' labor income been changing?

We can't control weather, but we are learning more about the kind of weather that helps to produce the best corn crop (page 3).

Volume 1, Number 4 UNIVERSITY OF ILLINOIS COLLEGE OF AGRICULTURE URBANA, ILLINOIS

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ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

CONTENTS

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Louis B. Howard . . . . Dean and Director
Tom S. Hamilton . . . . Associate Director
Adrian Janes . . . . Station Editor
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THE PRINCIPAL PURPOSE OF A UNIVERSITY

is to teach students and to open up for them a broader view of the world about them, with its opportunities for work and service and greater cultural enjoyment. How, then, does this objective relate to research, which this publication reports?

The obvious answer is that the research of a university is basic to teaching. Without the sound scientific facts revealed by research, teachers in the College of Agriculture could propound only opinions and half truths to their students.

Whom do we teach in agriculture? About 75 percent of our students come from rural areas, and 25 percent from cities and towns.

How many do we teach? In the College of Agriculture each year, we enroll about 900 undergraduate students in agriculture and about 400 in home economics. In addition, about 400 graduate students are working for advanced degrees.

What do they study? Our students obtain a good sound general education, including rhetoric, mathematics, science, the humanities, and the social sciences. They can then specialize in almost any area of agriculture or home economics, or obtain a more general training with less intensification.

Where do our students go? A 1950 census of previous agriculture graduates showed that 25 percent went into farming, 25 percent into agricultural business and industry, and 30 percent into agricultural education, while 13 percent became professional technicians, working as agronomists, agricultural engineers, and the like. The other 7 percent entered such professions as medicine, the law, or the ministry.

The college solicits the help of all who are interested in encouraging more young people to improve their minds and skills by education in agriculture. — *Karl E. Gardner, Associate Dean*

Dr. Gardner succeeded Harold W. Hannah as Associate Dean of the College of Agriculture on August 1 this year. He is also Professor of Nutrition in the Department of Dairy Science, having been associated with that department for 19 years.

Abundant rainfall during July, and from mid-August to nearly mid-September, helps to produce a good soybean crop.

Effects of Weather on Corn and Soybean Yields

R. T. ODELL

It doesn't take a sweltering summer to produce a good corn crop. In fact, below-average maximum temperatures in mid-summer help produce top corn and soybean yields in central Illinois. Even more important is abundant rainfall while the crops are growing rapidly.

To determine the weather pattern most favorable for corn and soybeans, Mr. E. C. A. Runge and I recently compared long-time yields with weather conditions, such as rainfall and maximum daily temperatures, during the growing season. We were especially interested in determining the periods when weather affects yields the most. Weather data used were from the official Urbana station, and crop yields were from the Agronomy South Farm.

Corn

Corn yields are influenced most by weather conditions immediately before and during the full-tassel stage. This conclusion was reached after studying first-year corn yields from 1903 through 1956 in a corn-corn-oats-red clover rotation.

Open-pollinated corn was grown through 1939 and hybrid corn from 1940 on. To put all yields on a comparable basis, we determined the relation between yields of open-pollinated and hybrid corn in central Illinois corn performance tests. Using this relation, we then converted open-pollinated yields to their hybrid equivalent.

R. T. Odell, Professor of Soil Physics, is in charge of soil survey work in Illinois. He has also done intensive research on the effects of soil characteristics, management practices, and weather on crop yields.

Yields of first-year corn showed a significant upward trend during the entire period. This trend may have been due to one or more of several causes — such as improved varieties of open-pollinated and hybrid corn, improvement in cultural practices, addition of limestone in 1946, and possibly weather cycles.

Two approaches were used in analyzing the relationships between yields and variations in rainfall and maximum temperatures. One was to study the relationships within fixed calendar periods each year. The other was to study a period which consisted of a specific number of days before and after corn tasseling so that the dates varied from year to year.

Fixed calendar period. The 112-day period from May 12 through August 31 was studied for each year. This period was subdivided into fourteen 8-day periods and different combinations of these periods were analyzed.

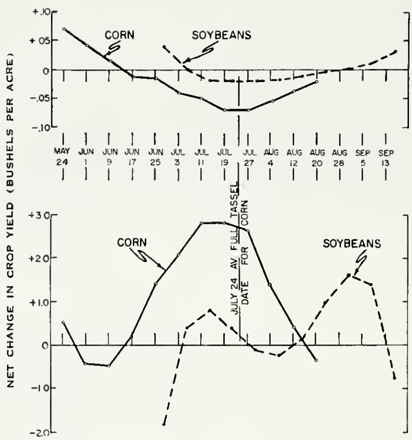
Fifty-eight percent of the yield variability over the 54-year span could be explained by rainfall and temperatures between May 20 and August 23 (twelve 8-day periods). This was a higher percentage than was obtained for any other fixed period. Rainfall had a greater effect than did temperature. The effects of above-average rainfall and maximum temperatures for each 8-day period are shown in Figure 1 (page 4).

It was assumed that an inch of rainfall below the average for an 8-day period would have an effect on yields just opposite to the effect of an inch above the average. Similarly a degree of below-average maximum temperature would have the opposite effect of a degree of above-average temperature.

A further assumption was that the total effect of variations in rainfall or maximum temperature would be directly proportional to the extent of these variations. For example, 1 inch of rainfall above average at the average full-tassel date would increase corn yields by about 2.8 bushels an acre (Fig. 1); 2 inches would increase yields by about 5.6 bushels.

Using the same calendar period every year tended to blur the effects of rainfall and temperature on yield, because of the year-to-year variations in planting date and rate of corn growth. By using a variable calendar period, tied to the date of tasseling each year, we were able to pinpoint more exactly the effects of weather variations.

Variable calendar period. A 64-day period, extending from 50 days before full tassel to 14 days after, was found to be of utmost importance to the corn crop. Variations in rainfall and maximum daily temperatures during this period ac-



HOW CORN AND SOYBEAN YIELDS are affected by variations in maximum temperatures and in rainfall during successive 8-day periods of the growing season.

***At top left,* net change in yield for each degree F. above the 8-day average maximum temperature, assuming normal rainfall for each 8-day period.**

***At bottom left,* net change in yield for each inch of rainfall above the 8-day average rainfall, assuming normal maximum temperatures for each 8-day period.**

(Fig. 1)

counted for 66.9 percent of the yield variability. When the upward trend in yields was included in the analysis, about 75 percent of the yield variability was explained.

A yield reduction of .05 bushel per acre is associated with each degree of above-normal maximum temperature when the corn is near full tassel. An inch of above-normal rainfall, coming a week before full tassel, will usually increase yields by about 4 bushels (Fig. 2).

Soybeans

Rainfall influences soybean yields differently than corn yields. This is evident from a 1909-1957 study of soybean yields in a corn-corn-corn-soybean rotation. During this period there was an upward trend in soybean yields. Most of it was due to changes in varieties from Ebony (1909-1925) to Illini (1926-1949) to Hawkeye (1950-1957).

The period from June 25 through September 20 is most crucial for soybeans. Variations in rainfall and maximum daily temperatures during this period explained 68 percent of the variations in yields.

The response of soybeans to above-average rainfall is quite different during various stages of growth. There is normally plenty of moisture early in the growing season, and above-average rainfall before July 1 is detrimental (Fig. 1). Yields increase, however, with abundant rainfall during July, when the plant is growing fastest and is blooming.

During the first half of August, when soybeans are usually in the early pod stage, the picture changes again. Above-average rainfall at this time slightly reduces yields. Hard rains and associated cloudiness during this sensitive period may cause some young pods to drop off.

From the middle of August to nearly the middle of September, the grain-filling period, above-average rainfall is once more beneficial. Rainfall after mid-September, however, is more than adequate and is associated with reduced yields, which are probably due to lodging, shattering, and consequent harvesting losses.

Above-average maximum temperatures are good at the very beginning and the very end of the June 25-September 20 period (Fig. 1). Through most of the period, however, they are detrimental.

Ideal Weather

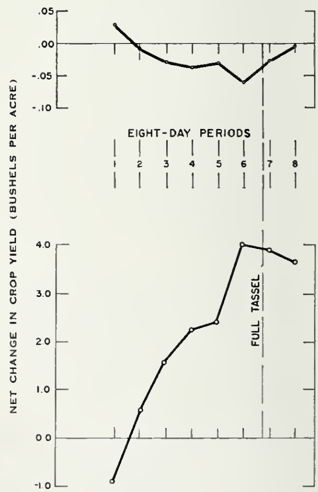
As the foregoing paragraphs have indicated, ideal weather for corn isn't always ideal for soybeans. Through a good part of the growing season, however, the needs of the two crops coincide.

Cooler-than-average temperatures in July and early August help produce high yields of both corn and soybeans.

Below-normal rainfall is desirable from planting time to mid-June for corn, and through June for soybeans. Both crops thrive on abundant rainfall during July, when they are growing rapidly. This is especially true in late July, when corn is tasseling and soybeans are blooming.

From August 1 until mid-September, above-average rainfall has opposite effects on corn and soybeans. If it comes during the first half of August, it increases corn yields, but slightly reduces the yields of soybeans, which are usually in the early pod stage at that time. From mid-August to nearly mid-September, however, above-average rainfall increases soybean yields, and decreases corn yields.

After mid-September, below-normal rainfall is desirable for both crops.



HOW CORN YIELDS are affected by variations in maximum temperatures and in rainfall during eight 8-day periods including 50 days before and 14 days after full tassel. *At top,* net change in yield for each degree F. above the 8-day average maximum temperature, assuming normal rainfall. *At bottom,* net change in yield for each inch of rainfall above the 8-day average rainfall, assuming normal maximum temperatures. (Fig. 2)

MOISTURE USED BY CORN

On a Silt Pan Soil in Southern Illinois

L. E. GARD

EVEN SHORT DROUTHS have often drastically reduced corn yields on the silt pan soils of southern Illinois. This is true despite the fact that, in most growing seasons, the available moisture is mathematically enough for a 125-bushel crop.

Water Supply and Requirements

Under average summer temperatures in southern Illinois, 18 to 21 inches of water are used to produce a 125-bushel corn crop. This has been indicated by corn-soil moisture studies conducted at the Dixon Springs Experiment Station from 1955 through 1958.

Average rainfall during the corn growing season (May 15 through September 12) for the 21-year period 1938-1958 has been 14 inches. In addition 16 inches of available moisture from winter and spring rains can be stored in the top 60 inches of soil, making a total of 30 inches potentially available for the corn crop. Unfortunately, however, the soil is seldom filled to more than three-fourths capacity at corn planting time. Furthermore, on silt loam soils in southern Illinois, the corn plant can utilize very little of the moisture below 24 inches.

Water Used by Corn on a Silt Pan Soil, With and Without Irrigation; and Acre Yields (1955)

Source of water	No irrigation	2 irrigations[a]	5 weeks irrigation[b]
Soil horizon	*water use, inches*		
0-6"	1.43	1.18	.90
6"-12"	1.25	.91	.74
12"-18"	1.04	.81	.36
18"-24"	.71	.55	.17
24"-36"	.36	.32	.06
36"-48"	.08	−.04	.14
Total	4.87	3.73	2.37
Rainfall	10.88	10.88	10.88
Irrigation water	0	4.00	6.33
Total water use	15.75	18.61	19.58
	bushels per acre		
Corn yield	94	123	128

[a] Two 2-inch applications, one at tasseling and one at shooting.
[b] Enough water applied to equal 2 inches each week; eighth through twelfth week after planting. Rainfall during the seventh week equaled 2 inches, making irrigation unnecessary.

Corn Grown With and Without Supplemental Water

Our studies were conducted on Grantsburg silt loam, a fragipan soil. Corn was grown both without irrigation and with medium and high amounts of supplemental water. The medium irrigation consisted of two 2-inch applications, one when the corn was in the early tassel stage and another 10 to 14 days later. The high level consisted of enough water to bring the total supply, including rainfall, up to 2 inches a week for the seventh through twelfth week after planting. (No plots were irrigated in 1958 because of unusually heavy summer rains.)

Water Used From Lower Horizons

Of the total water utilized by unirrigated corn, the amount supplied from below the 24-inch level averaged only about 6 percent for the 4-year period; and in none of the measurements did it exceed 12 percent. Whenever the water supplied from below 24 inches did approach 12 percent of the total, yields were materially reduced. In 1955 less than 3 percent of the water came from below 24 inches (*see* table).

Irrigation decreased the amount of water that was supplied from below 24 inches. The 3-year (1955-1957) average was less than 4 percent on plots receiving medium irrigation. On heavily irrigated plots, only 2 percent of the water used in producing the crop came from below 24 inches. As shown in the table, the percentages for 1955 were considerably lower.

Irrigation Valuable

Average acre yields for 1955, 1956, and 1957 were increased 27 bushels by two 2-inch applications of irrigation water, put on at tasseling and shooting stages. Plots receiving heavy irrigation yielded 32 bushels an acre more than the unirrigated plots.

On the basis of these results, plus a study of rainfall amounts and patterns over a 21-year period, irrigation seems to be an economical, sound practice in 3 out of 4 years.

Usually irrigation is not necessary for the first 6 or 7 weeks after the corn is planted. In only 1 year out of 21 (1944), was there an inadequate moisture supply during the first 45 days after planting.

Conditions are most likely to be critical from the eighth week after planting throughout the twelfth week. Under average temperature conditions, moisture was used at the rate of ⅓ inch a day during the tenth and eleventh weeks. When temperatures and winds are high, this rate may increase to ½ inch a day.

The use of other good agronomic practices, especially an adequate fertility program, should accompany an irrigation system.

L. E. Gard, Assistant Professor of Agricultural Research at the Dixon Springs Experiment Station, joined the University staff in 1949. Before then, he conducted research for the Soil Conservation Service in the Dixon Springs area.

CAN DEER SPREAD DISEASE?

D. H. FERRIS

At least 25,000 deer now roam the woodlands and prairies of Illinois. This is 10 times as many as there were 10 years ago. By 1957 the deer population was great enough that Illinois had its first deer hunting season in 50 years.

No less surprising than the upward surge in numbers has been the geographic spread of deer. In 1947, they were reported from 47 counties, but the majority were concentrated on a few ranges, such as the Rock river region in the northern part of the state and portions of the Shawnee National Forest in the southern part. Deer have now been reported in all counties, and 33 counties have had populations large enough to permit hunting.

D. H. Ferris has been on the staff of the College of Veterinary Medicine and of the Agricultural Experiment Station since 1957. He is Associate Professor of Veterinary Pathology and Hygiene. The fawn, shown here when 5 weeks old, is an orphan that Dr. Ferris is raising at his home.

Research Program Developed

In the northern tier of states and in Canada deer are instrumental in spreading liver rot (caused by a liver fluke) to cattle. Deer purchased in another state and brought into Illinois have died from active tuberculosis. Thus, the increased number of deer in the state is a potential danger to livestock and man.

The inauguration of hunting seasons presented an opportunity to make a large-scale investigation of deer as possible disease reservoirs and carriers. In 1957 a research program on deer diseases was instituted cooperatively by the State Department of Conservation, the College of Veterinary Medicine, and the Agricultural Experiment Station.

This research included many tests of deer blood sera for evidence of infection by Brucella, Leptospira, and other organisms; the isolation of disease agents by parasitologists and microbiologists; studies of deer tissues by pathologists; and analysis of such data by epizootiologists (persons studying natural history and spread of animal disease).

Deer Do Not Spread Brucellosis

Cattlemen and dairy herd owners have reported Brucella reactors in certified free herds. Deer have been suggested as one possible explanation of this disconcerting phenomenon. All research done so far, however, refutes this hypothesis. From surveys and experimental work in several states, it is clear that deer cannot be implicated in the spread of brucellosis.

More than a thousand deer sera have been tested in Illinois, but only one showed a positive reaction to the Brucella organism. (A positive reaction indicates that the animal has developed antibodies against a brucellosis infection.) Similar results have been found in each state making a survey. Other experiments have shown that deer are capable of forming large amounts of antibody against Brucella organisms. Thus the rareness of positive reactions would indicate that natural infection seldom occurs.

Deer May — or May Not — Spread Leptospirosis

At the request of many veterinarians, the possible spread of leptospirosis by deer is being investigated. As yet deer have not been cleared of responsibility as carriers of this disease.

About 20 percent of the blood sera tested in 1957 were positive to at least one kind of leptospiral organism. In 1958, 11.6 percent of a much larger sample were positive. The majority of the positive reactions were caused by *Leptospira pomona,* the same organism that accounts for most of the disease in livestock. *L. grippotyphosa* also caused a high percentage of reactions. Antibodies to this organism

Deer Hunters — Your Help Is Requested

With your deer permit, you will receive a plastic test tube and stopper. You are requested to fill the test tube with deer blood and turn it in at the deer check station. The blood tubes will be rushed to the College of Veterinary Medicine for processing. This is the first statewide collection of deer blood to be attempted.

have been found in the blood sera of Illinois cattle, indicating that *L. grippotyphosa* or a closely related form causes infection.

These facts do not necessarily mean that deer spread leptospirosis. It is possible that deer pick up the organism from cattle and that, after stimulating an antibody rise, it dies without escaping. A second possibility is that deer might shed leptospires in the urine for a short time only. This condition has been found to cause the spread of leptospirosis only on rare occasions.

There is, however, another, far more serious possibility — that deer might be long-term shedders of leptospires. Several deer were inoculated experimentally to determine their capability for eliminating leptospires and to measure their level of leptospiral antibodies after infection. No leptospires were recovered from the urine, but too few attempts were made to give a final answer. The antibody level rose quickly to a high peak and fell slowly during the next few months.

We urgently need not only more definite answers about *L. pomona,* but also information about other leptospiral serotypes found in deer. It is possible that deer may be a natural host to one or more of these organisms. This has been found true of other species — the rat, for example, customarily sheds *L. icterohemorrhagiae;* and the dog, *L. canicola.*

Difficulties of Studying Leptospirosis in Deer

The present lack of more definitive answers to the question of leptospirosis in deer is largely due to the difficulties of working with these animals. Deer are dangerous to their handlers, and also break their own legs or neck quite easily.

This has necessitated quite a bit of research on handling deer. Tranquilizers shot from a dart gun and others placed in feed have been found helpful, but the "perfect" tranquilizer has not yet been discovered. Research work has also been complicated by the need to measure the physiological disturbance caused by handling, as well as the effect of the leptospires.

For all these reasons research with deer requires much more manpower and time than similar experiments with livestock, and this in turn means that greater financial support is necessary.

Other Studies

Other diseases besides those mentioned are now being studied in various parts of the country. In southern and western states, for example, deer have been found to harbor anaplasmosis. They have also been suspected of carrying blue tongue of sheep.

More attention is being given to the natural diseases of deer. Epizootic hemorrhagic disease is one which could threaten our entire deer herd. The virus of this disease has been isolated from deer in New York and Wisconsin. It has definitely caused die-offs in deer in those states and is thought to have caused deaths in Missouri.

Although there is no evidence as yet that epizootic hemorrhagic disease attacks livestock, we are discovering that many disease agents have a wider host range than we had previously suspected. Microbes and parasites can move from one species to another. Examples of such diseases are rabies and trichinosis.

Changes in virulence may also occur, as in influenza of man. In 1918 a highly lethal mutant of this virus spread around the world, causing millions of deaths. At the same time it spread to our swine populations, and it still causes serious losses of these animals.

A Safeguard Needed

Between 1850 and 1870 the deer population in the Midwest is said to have reached a peak above anything previously known by the white man. Following this peak, the original white-tailed deer disappeared from Illinois, probably because of disease. The present population has resulted from restocking. Adequate research can enable us to safeguard this valuable resource, as well as our livestock.

Injections with Diquel, a tranquilizer, have quieted these deer enough that Dr. L. E. Hanson is able to hold one while Dr. A. B. Hoerlein draws blood from its jugular vein. Without the tranquilizer it would have taken two or three men to hold one animal. Drs. Hanson and Hoerlein are protecting their faces with fencing masks, as deer often slash at their handlers even when tranquilized.

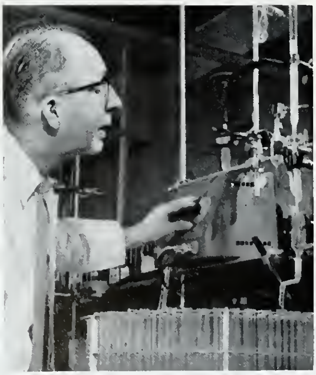
Why Does Cheese Taste Cheesy?

A study of the chemistry of Limburger has given some of the answers to this question

S. L. TUCKEY

THE ACCEPTABILITY OF A FOOD — whether it be cheese, strawberries, a steak, or any other — depends largely on the degree to which its characteristic flavor has been developed. But why does an apple taste like an apple, Roquefort cheese like Roquefort, Limburger like Limburger? Is one compound or a blend of several compounds responsible for a characteristic flavor? Answers to these questions have long been sought.

Although research on the flavor of foods has appealed to workers for many years, the obstacles to research in this area were so great that the results achieved were rather limited. As early as 1890, for example, bacteriologists in this country and Europe recognized that certain strains of sour milk bacteria produced cultured milk of excellent flavor and aroma which was due to a compound or compounds other than lactic acid. Not until 1929, however, did Van Neil, Kluyver, and Derx in the Netherlands identify the compound as being diacetyl (2,3 butanedione).



S. L. Tuckey, Professor of Dairy Technology, has been on the University staff since 1928. He has won the Borden Award for his work with dairy products. Here he operates a fraction collector, which separates the mixture of organic acids that give flavor to cheese.

Within the last 5 years, new analytical methods and equipment — and perhaps new concepts as well — have been making it possible to achieve remarkable results much more quickly than in the past.

Since 1952, the Department of Food Technology has been studying the chemistry of Limburger cheese and searching for the compounds that cause its flavor. The following paragraphs not only tell some of our results with Limburger, but also give brief summaries of what is now known about flavor in general and the chemistry of cheese in particular.

What Is Responsible for Flavor?

Workers in flavor chemistry agree that flavor materials contain four principal types of components:

1. **A primary component,** which may be a single compound or a group of compounds, and which is necessary to obtain the main flavor characteristics.

2. **Additional compounds** which give background support for the essential flavor and seem to blend or modify it. They carry no important flavor themselves.

3. **Materials** which neither contribute to nor detract from the essential component.

4. **Undesirable constituents** which detract from the over-all effect of the primary and secondary components, and which may eventually contribute to the development of off-flavors.

Cheese Flavor Is Complex

Since cheese is made from milk, it contains water, milk fat, proteins, sugar, minerals, vitamins, enzymes, and bacteria. It is a dynamic material in which innumerable biochemical reactions occur simultaneously and continuously. These reactions are caused by the enzymes and millions of bacteria in the cheese.

Compounds produced in the cheese during ripening include fatty and other organic acids, amino acids, ammonia, amines, aldehydes, ketones, alcohols, esters, and many more. In other words, almost all classes of chemical compounds have been identified in one or more varieties. Each compound has a flavor of its own. One compound may serve as the essential flavor component of one variety of cheese, and as a background component for another, depending on the concentration of the compound and its reactions with others.

Here the art of the cheesemaker comes into action. He varies certain steps in the manufacturing procedure, so that the bacteria and enzymes can produce the proper concentrations of chemical compounds and the cheese will have its "typical" flavor. Cheese and its flavor are almost a miracle when one considers the possible number of reactions that are required. One should not be surprised, therefore, at the number of non-typical flavored cheeses one is forced to buy before finding one that is really typical.

The complexity of the chemical reactions, and also the organized pattern in which these occur, are illustrated in the diagram on page 9, which is based on work done by Krebs in England.

One of the striking things revealed by this diagram is that regardless of the starting material — either fat, carbohydrate, or protein — it is pos-

sible to arrive at a common end product. Furthermore, it should be emphasized that many of the reactions are equilibrium reactions — that is, they do not all move in one direction — and that concentration of individual components is a controlling factor in determining rate of reaction. Not all the chemical compounds in the diagram have been isolated from every type of cheese, but each has been found in one variety or another.

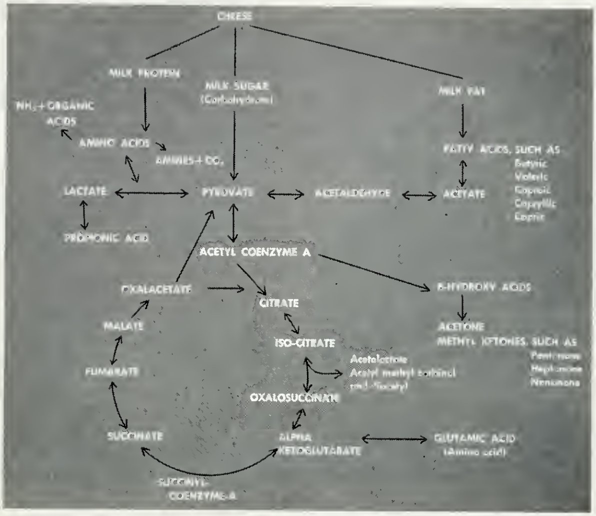
Flavor Compounds in Swiss and Roquefort Cheese

For a few cheeses, it is possible to identify by taste one or two of the compounds essential for flavor. The characteristic sweetish taste of Swiss or Emmenthaler cheese, for example, is due to propionic acid being in proper ratio to acetic and butyric acids. Off-flavors develop when any of these three acids is out of ratio with the others.

When one eats Roquefort cheese he is conscious of a number of flavored compounds. They include salt (sodium chloride), the fatty acids, butyric, caproic, caprylic, and capric; and finally, of great significance are acetone, pentanone, heptanone, and nonanone — the methyl ketones or carbonyl compounds which have been formed from the fatty acids. It is the presence of heptanone in the correct concentration that gives Roquefort cheese its pleasing piquant flavor. If only the fatty acids are present, the cheese is likely to be criticized as being "soapy" and "bitter."

Cause of Limburger Flavor Not Easy to Identify

When we began our study, we thought it might be relatively easy to isolate the compound causing the unique and potent flavor of Limburger cheese. This, however, has not turned out to be true. Actually, the identification of any flavor compound is not simple — as is indicated by the existence of the four types of flavor components already mentioned.



The sequence of changes believed to occur during cheese ripening.

While we cannot as yet completely answer the question as to why Limburger tastes as it does, our search has yielded some results. It has added to our knowledge not only of Limburger flavor but also of the chemistry of ripening in this cheese.

Chemical Changes Typical of Limburger Cheese

The hydrolysis or splitting of the protein curd by enzymes, resulting in the formation of amino acids, is a characteristic and necessary change in cheese ripening. Although no single amino acid directly determines the flavor of Limburger, it was found that the characteristic flavor does not develop unless ammonia can be detected by taste. Ammonia is necessarily formed when certain organic acids are liberated from amino acids. Hence, amino acids contribute indirectly to flavor.

At the present time, three amino acids — valine, leucine, and isoleucine — are being studied intensively. We have found that after ammonia is split from these acids, the organic acid residues are potent flavor compounds. We have also found that some of these residues (valeric, isovaleric, butyric, and ketobutyric acids) tend to increase as Limburger flavor develops.

Another major constituent of the cheese curd which undergoes complete hydrolysis very early is the carbohydrate. This is converted to a lactate compound. A study of the metabolism of lactate during the ripening of Limburger cheese has also provided us with important clues as to flavor development. We have discovered that lactate or lactic acid rapidly decreases during ripening while acetic and propionic acids remain fairly constant. Experience has shown that "off-flavors" develop if lactate is not metabolized, or if acetic or propionic acid increases during ripening.

The carbonyl compounds (ketones, aldehydes, and keto acids) as a class are aromatic and flavorful — pleasant as well as unpleasant. At least eight different carbonyls have been found in Limburger cheese, and they too undoubtedly contribute to its characteristic flavor.

Further research is being done so that we can specifically identify the Limburger flavor and completely answer the question, "Why does cheese taste cheesy?"

CHRISTMAS TREES —

A New Crop on Illinois Farms

J. N. SPAETH

THE CHRISTMAS TREE industry is big business. Last year 40 to 50 million trees were sold in the United States — more than 3 million in Illinois alone. We may expect the demand to increase with the growth of our population.

Of all the trees used in Illinois last year, only 2 or 3 percent were grown in the state. Most of the others came from wild forest lands in Canada and the northern lake states. Will this trend continue in the future? Can Christmas trees ever become an important farm crop in Illinois? To shed some light on this question, the Illinois Agricultural Experiment Station has cooperated with other midwestern states in a regional study of the Christmas tree industry.

The study was concerned with the number of trees used, the present supply, consumer preferences, marketing procedures, and the present trend toward local production of cultivated trees. Information was collected from cities and towns of all sizes. Results are to be combined in a report for the whole region, since the business is not limited by state boundaries.

The cooperating experiment stations drew different assignments. Illinois' assignment was to study the situation in the city of Chicago, with a population of 3,621,000. A supplementary survey of consumer preferences was made in Champaign-Urbana. A state-wide study of the present status of Christmas-tree growing in Illinois was also made.

J. N. Spaeth, Professor of Forestry and Head of the Department, is especially interested in the study of silviculture and of forest ecology, or the relation of woody plants to their surroundings.

Kinds of Trees

Most Christmas trees enter the Chicago market by rail. Of the 670,000 trees received at the "Christmas tree tracks" in 1956, 611,000 were fir trees and 39,000 were Scotch pine. This should not, however, be taken as evidence that nearly all consumers want fir in preference to other species. When given a free choice of five species, as many homeowners in Champaign-Urbana chose Scotch pine as chose fir. A study of trees used by Chicago business establishments, industries, and institutions indicated a preference for Scotch pine.

Fir has always been the most abundant species suitable for Christmas trees, growing wild in the northern coniferous forests; and the harvesting and marking channels are highly organized. It is therefore readily available to wholesalers, and through them reaches the retail market. Many retail outlets in Chicago were found to offer only fir.

In 1958, 178,000 fewer trees reached the Chicago market by rail than in 1956, and a higher proportion of these were Scotch pine. The reduction in rail receipts was in part due to unfavorable weather for cutting and shipping trees in the northern forests, particularly in eastern Canada. Undoubtedly, it was due in part also to the increasingly poor quality of fir and the rising popularity of Scotch pine and other species which are reaching the market by truck from Illinois and adjacent states.

It is not likely that the northern fir species will be grown successfully in Illinois, but Scotch pine is well adapted to much of our poorer land. Douglas fir (which is not a true fir), red pine, white pine, spruce, and red cedar are other species which may be grown in Illinois and which are the first choice of some families.

Quality

All studies indicate that quality is more important than either species or price. Of the homeowners questioned in Chicago, 51 percent did not know what species they bought, but many of them said they selected the best tree on the lot. Wholesalers, retailers, and consumers alike complained about the poor quality of most of the trees, and each insisted that he wanted to buy the best available.

In the regional study, eight states surveyed the quality of Christmas trees offered for sale on selected lots. Four grades were established, and a random sample of trees was graded on each lot visited. Results are shown in Table 1.

Kansas and Nebraska were the only states where the proportion of premium grade trees was high. Also they were the only states where most of the trees used were Douglas fir from the western states.

In Illinois only 5.4 percent of the trees were of premium quality — more than half were very poor quality (utility or cull). Herein lies the opportunity for Illinois growers. The supply of good trees from the wild forest lands in the north is practically exhausted. Local growers can pro-

Table 1. — Quality of Trees of All Species Offered for Sale in Selected Retail Lots of Eight States, 1956

State	Percentage of trees in each grade			
	Premium	Good	Utility	Cull
Illinois	5.4	39.8	43.2	11.8
Iowa	10.2	38.3	41.7	9.8
Kansas	21.6	50.3	24.2	3.8
Michigan	7.0	32.8	53.0	7.2
Minnesota	10.0	30.0	44.0	16.0
Missouri	16.9	37.0	32.5	13.6
Nebraska	31.8	41.3	21.8	4.9
Ohio	5.5	25.7	49.3	19.5

Getting ready to sell Christmas trees at the farm (above).

Home owners want a high-quality tree — symmetrical and moderately dense like the one at right.

duce a high percentage of premium trees in managed plantations by cultivation and shaping. All studies show that the demand for high-quality trees greatly exceeds the supply.

The U. S. Department of Agriculture has recently issued standards for grading Christmas trees. These standards enable producers and purchasers to specify quality grade on a national scale.

Where Retailers Buy Their Trees

Most Chicago retailers buy their trees from large wholesalers. Less than 10 percent secure trees from local growers, truckers, or their own plantations. Other states found that in smaller communities a much larger proportion of the trees came from the latter sources. It is probable that this is also the case in Illinois. In Michigan, where many growers are raising Scotch pine in plantations, 40 percent of the retailers secured their supply from local growers.

The Illinois Supply

Growing Christmas trees is a relatively new venture for Illinois landowners, but the interest in this new crop has spread rapidly. Is production now likely to exceed the demand? There is no simple answer to this question, because many factors must be taken into account. As already mentioned, there is a large demand for trees of high quality.

One phase of our study was to estimate the number of trees now being grown. This was done by enlisting the cooperation of members of the Illinois Christmas Tree Growers' Association and by studying a random sample of those who have purchased suitable species from the tree nurseries of the Illinois State Division of Forestry. The estimated number planted for Christmas trees from 1948 through 1957 is shown in Table 2.

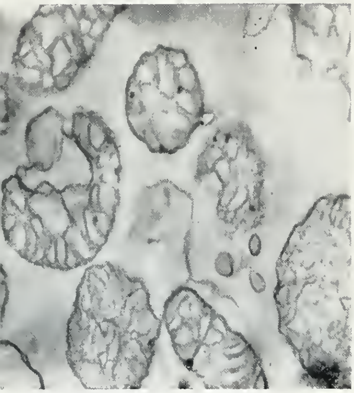
Many planted trees are lost in unfavorable seasons. Others are neglected, or fail to develop into acceptable specimens even with proper care. It is quite possible that not more than half the trees planted will ever reach the market. On this basis it would appear that, as yet, there is no overproduction in this state if local growers can capture a major portion of the Illinois market.

The most striking feature in Table 2 is the steady increase in the number of Scotch pine planted. This species is hardy, and the skillful grower can produce a high percentage of premium trees by proper management and shearing. Consumers will accept Premium and Number 1 quality trees of almost any species.

Table 2. — Species and Estimated Number of Christmas Trees Planted in Illinois by Year, 1948-1957

Species	Number of trees planted per year, thousands										
	1957	1956	1955	1954	1953	1952	1951	1950	1949	1948	Ten-year total
Cedar, red	29.0	10.0	10.0	30.0	25.0	25.0	61.0	....[a]	....	....	190.0
Douglas fir	67.3	85.0	18.0	37.0	....	10.0	....	....	....	5.0	222.3
Pine, jack	230.1	285.0	244.0	169.0	91.0	325.5	110.0	7.0	12.0	11.0	1,484.6
Pine, red	666.1	475.5	392.0	177.0	351.5	245.0	209.0	92.0	10.0	5.0	2,623.1
Pine, Scotch	1,742.3	1,764.0	851.5	561.0	386.0	431.5	85.0	30.0	33.0	5.0	5,889.3
Pine, Virginia	....	10.0	10.0	10.0	20.0	10.0	20.0	70.0	10.0	30.0	190.0
Pine, white	279.0	95.0	64.0	56.0	202.5	96.0	203.0	37.0	3.0	....	1,035.5
Spruce, Norway	26.0	20.0	18.0	51.0	29.0	15.0	....	52.2	....	5.0	216.2
Spruce, white	35.0	30.0	41.0	11.0	6.0	16.0	9.0	3.0	....	5.0	156.0
Miscellaneous[b]	62.0	78.5	20.5	....	5.0	20.0	21.0	30.0	12.5	....	249.5
Total	3,136.8	2,853.0	1,669.0	1,102.0	1,116.0	1,194.0	718.0	321.2	80.5	66.0	12,256.5

[a] None reported.
[b] Pines (Austrian, loblolly, pitch, ponderosa, shortleaf), blue spruce, and balsam fir.



Mitochondria from corn shoots (*electron-micrograph by Dr. A. E. Vatter*). **(Fig. 1)**

MITOCHONDRIA—

Power Plants in the Cells

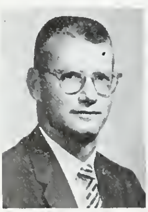
JOHN B. HANSON

THE SMALL OBJECTS in the photograph are mitochondria isolated from corn shoots. If they had been isolated from soybeans or hog liver they would appear pretty much the same. Furthermore, they would behave in a similar fashion in a test tube. The study of mitochondria, in fact, takes the study of life down to a level where it is rather difficult to distinguish between corn plants and farmers.

What Are Mitochondria?

Mitochondria are tiny organelles comprising part of the cytoplasm (living substance) of plant and animal cells. (An organelle is a specialized part of a cell, functioning somewhat as organs do in the body.) It would take 30 to 40 thousand mitochondria end to end to measure 1 inch.

Each mitochondrion functions as a miniature biochemical power plant (Fig. 2). In effect it strips electrons from reduced carbon atoms, shuttles them along enzymatic pathways, and eventually dumps the electrons on oxygen, which becomes water. This function of oxygen as an electron acceptor is quite critical, and people and plants die quickly without it. They also die from lack of reduced carbon (foodstuffs) but more slowly.



John B. Hanson, Associate Professor of Agronomy and Botany, is on leave of absence this year, having received a Fulbright grant to study as a research scholar at the University of Adelaide, Australia. He has been at Illinois 6 years.

Mitochondria Help Furnish Energy

The passage of electrons from carbon to oxygen is essential to life because it is coupled to the formation of energy-rich organic phosphate compounds, which in turn provide energy for biological syntheses and work. The kick of a mule and the growth of a root are examples of work powered by the respiration carried on by mitochondria. The process is analagous to that by which electron flow from the negative to the positive pole of a battery is coupled to work by means of an electric motor.

Connection With Ion Absorption Is Studied

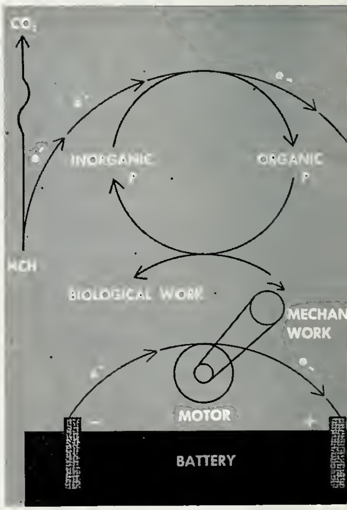
The Department of Agronomy has been studying plant mitochondria over the past 4 years in an effort to relate energy production to plant growth and the absorption of nutrient ions by the roots.

Corn mitochondria grow as the cell grows. Plant hormones probably govern this growth. The mitochondria reach optimum activity just when the cell reaches maximum size. At this point the speed of ion uptake is also at its greatest. As the cell matures, the mitochondria decline in activity and so does ion absorption.

Mitochondrial growth involves the formation of many internal membranes (Fig. 1). These appear to be the site of enzyme activity.

Our current research indicates that a minor but very important constituent of membranes is ribonucleic acid (RNA). If the RNA of the mitochondria is degraded, or reduced in complexity, they will no longer "couple" the electron transfer to phosphorylation (the formation of phosphate compounds), and the roots will stop taking up nutrient ions.

Enzymes that will degrade mitochondrial RNA are present in the cell, but normally these enzymes are not effective because the RNA is protected by adsorbed calcium and magnesium ions. One effect of soils low in lime is probably to permit some degradation of the essential mitochondrial "machinery."



Electron transfer by mitochondria is similar to that in an electrical system. Both are coupled to work. (Fig. 2)

Changes in LABOR INCOME of Illinois Farm Operators

JOHN HERBST, author of this report, is Assistant Professor of Agricultural Economics and Vocational Agriculture. He has been at the University 4 years, having previously taught vocational agriculture in Illinois high schools.

An average farm worker in the United States today produces agricultural products for about twice as many people as 20 years ago. According to estimates by the U. S. Department of Agriculture, one farm worker produced enough for 10 other people in 1940, and enough for 23 others in 1957.

During the 1940-1957 period, farm output per man hour doubled. Between 1948 and 1956, it increased by about 41 percent, according to indexes published by the Bureau of the Census, while output in manufacturing industries rose 28 percent.

Although man-hour output since the war has increased at least as fast in agriculture as in industry, agricultural workers are still working more hours a week than industrial workers. The Bureau of the Census has reported that in 1957 farm workers averaged 46 hours a week as compared with 40 hours in industry.

These figures raise questions as to farmers' labor income. Has it increased as much as their expanded hourly output would suggest? Has it increased as much as the wages of factory workers? Has it changed more in one area than in another?

To help determine the changes that have taken place in Illinois, Census data for 1944, 1949, and 1954 were studied. These data are reported on the basis of the economic areas shown in Figure 1. In the reporting, some of the areas are grouped together and considered as one.

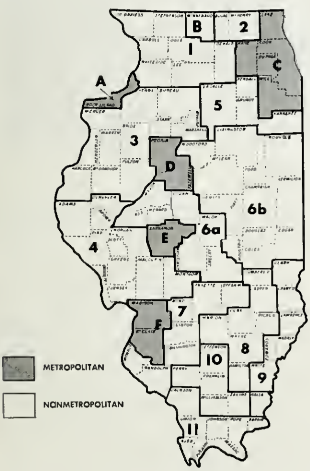
The labor income of farm operators was determined by subtracting all other costs from the gross value of production on commercial farms. (These costs include cash operating expenses, depreciation, the value of family labor, and interest on investment in machinery, equipment, livestock, buildings, and land.) Crop sales were adjusted according to 5-year average yields.

The value of agricultural labor was estimated on an annual basis. If farmers in an area spent an average of 2 months in off-farm work, their average monthly income for the other 10 months was multipled by 12 to get the annual farm labor income.

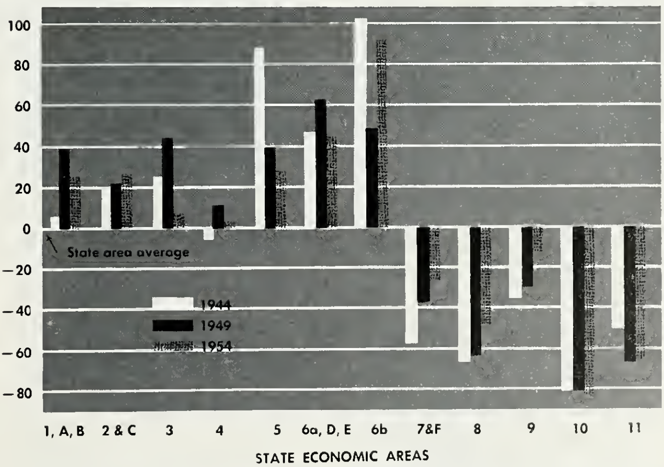
Farm Labor Income in Different Areas

In each of the three years studied, farm labor income varied widely from one part of the state to another (Fig. 2). Between 1944 and 1954, the areas did not move significantly closer together in average labor income per farm operator, although there were some changes.

Of the seven northern and central



Economic areas of Illinois. (Fig. 1)



How different areas of Illinois compared in labor income of farm operators. Expressed as the percentage by which farm labor income in an area deviated from the average of all areas in the state. (Fig. 2)

Illinois areas, three ranked relatively higher in 1954 than in 1944, and four ranked lower. Southern Illinois areas 7 and F, 8, and 9 moved closer to the average during the period. Areas 10 and 11, however, were farther from the average in 1954 than in 1944.

The labor income of farm operators may have been somewhat understated for areas having smaller or older farm machines than the average. To find depreciation and interest for each area, the same value was assigned to every machine of a given type, and was multiplied by the number of machines reported in the Census. However, it does not seem likely that this item would affect relationships among the areas over a period of time.

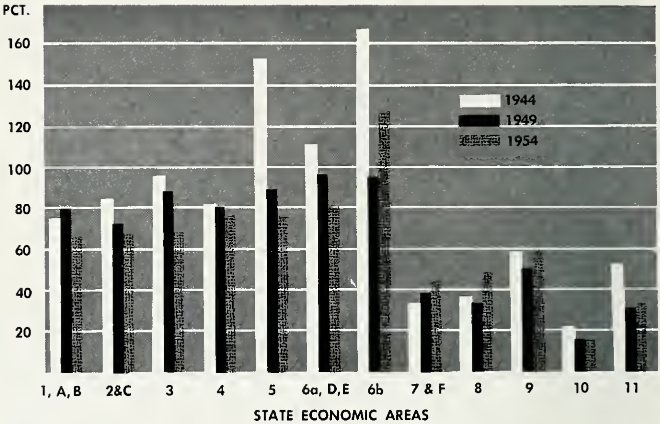
Labor Income and Factory Wages

How the labor income of farm operators changed in comparison with wages of factory workers is shown in Figure 3. In most areas of the state, farm labor income did not advance as rapidly between 1944 and 1954 as did factory workers' income.

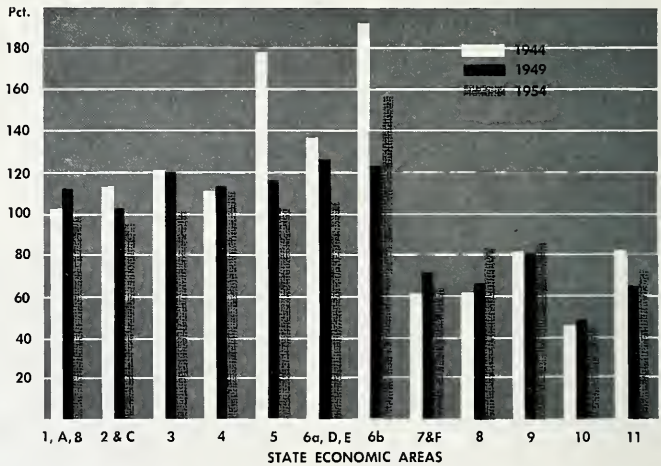
By adding to operator labor income the amounts that were allowed for family labor and interest on the machinery, equipment, and livestock investment, we obtained a figure roughly equivalent to agricultural earnings of a tenant family. When earnings of capital were included, the disparity between agricultural earnings and factory wages was, of course, less than when only labor income was considered (Fig. 4). Apparently, there was also less change between 1944 and 1954.

Prices Paid for Family Living

Changes in prices paid for family living items were about the same for nonfarmers as for farmers during the period considered. The consumer price index, representing changes in prices paid for family living items in cities, was 53 percent higher at the end of the period than at the beginning. The farm family living index, representing changes in prices that farmers paid for family living items, increased by 56 percent.



Labor income of farm operators as a percentage of the earnings of factory workers. Wages of factory workers were estimated from Illinois Department of Labor and State Employment Service data. (Fig. 3)



Family earnings from farming expressed as a percentage of the earnings of factory workers in Illinois. Earnings of the land and building investment are noi included. (Fig. 4)

Adjustments Taking Place

Although migration from farms proceeded rapidly during 1944-1954, it apparently wasn't great enough to tend toward the equalization of farm labor income and factory wages. However, continuing adjustments may in time bring labor income of the two groups closer together. These adjustments include: (1) Further migration from farms. (2) Increased amounts of land and capital per farmer. (3) More off-farm work, particularly when the farm business cannot be expanded. With fewer months actually spent on the farm, average monthly farm labor income can increase.

The Extension Program in FOOD MERCHANDISING

GEORGE M. ENGLAND

ILLINOIS FARMERS are among the most efficient producers in the world. But efficiency in marketing is lagging far behind efficiency in production.

More than ever before, farmers are dependent on marketing services to process, transport, and sell their products. Waste and inefficiency in these services mean higher prices to the consumer without any increase in prices received by the farmer.

This represents a challenge that the State Extension Services are trying to meet. In the past they have been primarily interested in helping farmers to produce more efficiently, but in recent years they have been giving more attention to marketing problems. Much of this expansion in the Extension program has been made possible through the Agricultural Marketing Act of 1946.

Part of the program has been to help growers market their commodities more efficiently. In addition, the Extension Services have begun to tackle the whole complex problem of wholesaling and retailing food. Illinois is one of 24 states that now have Extension specialists in retail and wholesale marketing.

Many Problems Are Being Studied

The Extension Services, of course, are not the only organizations trying to improve our marketing system. Many government agencies, colleges, universities, and private firms are doing research on the problems of food marketing. This research has included work on areas of management, traffic patterns, and the marketing of special commodities; time and motion studies; and cost and efficiency analyses of operations in retail stores and warehouses.

As a result, our fund of knowledge is growing. We are finding out where the weaknesses are and are also learning new ways to reduce waste, to improve facilities and handling methods, and to use labor more efficiently.

A big opportunity for reducing food costs has been found in just the one area of labor efficiency. According to the latest studies, the large number of people engaged in the retailing and wholesaling of food are working at approximately 50 percent capacity.

Much labor inefficiency is due to present methods of food handling. Many products are handled 25 or more times as they move through the distribution system. Improved facilities and methods will reduce the number of handlings, thereby cutting costs.

After the product has reached the retailer, savings can also be made through improved methods, materials, and equipment; and through efficient storage, refrigeration, inventory controls, and sales accounting.

Help Given to Food Stores

Extension marketing specialists acquaint firms with the latest technological developments and also give the following types of assistance:

1. Help in increasing operational efficiency through better selection and use of labor, facilities, and equipment.

2. Help in maintaining and improving product quality by demonstrations of better handling methods.

3. Improvement of marketing organization and structure by providing information on location of facilities, type of market, and design and layout.

This assistance may be given at group meetings and training schools. For example, a training program in work methods, materials handling, and operational efficiency may be conducted for a group of proprietors and employees. Or owners and designers may receive instruction in layouts of stores and warehouses.

Special assistance is also available, upon request, to individual stores or chains. Several cooperative retail groups and a retail chain in Illinois have availed themselves of this assistance. So far, the operational efficiency of 10 supermarkets and 2 wholesale warehouses has been studied; and 8 customer flow studies have been made. In addition, 20 store supervisors have been trained to make such studies. Since each supervisor visits a large number of stores, the results of marketing research have thus become more widely available.

One cooperative retailing group is now sending blueprints of their new supermarkets to the department for evaluation.

An Expanded Program

The Extension marketing program at the University of Illinois, as in other states, will expand as demand requires.

More knowledge about marketing farm products, leading to better and lower cost marketing methods, will help everyone. Farmers will benefit from wider and stronger demand for their products, which strengthens farm prices. Marketing firms will benefit through increased profits and better service to their customers. And consumers will benefit through improved quality and reduced prices of products and services.

The net result is to provide a more efficient pipeline for moving the output of the nation's farms to their 170 million customers.

George M. England, Associate Professor of Agricultural Economics, came to the University of Illinois 2 years ago to take charge of the present Extension program on food merchandising.

RESEARCH IN BRIEF

Man's Requirement for Magnesium

The Nutrition Research Division in Home Economics is undertaking a new study on man's requirement for magnesium and the factors that determine this requirement.

Up to now little attention has been given to this subject. Although magnesium is a constituent of every cell in the body and hence is essential in the diet, it is present in all common foods. Hence the assumption has been made that almost any diet will supply enough magnesium for human needs. However, judging from recent investigations with laboratory animals, this may not necessarily be true.

Various investigators have shown how rats, dogs, calves, and poultry react to diets very low in magnesium. Convulsions are perhaps the most obvious symptom. This condition is extremely rare in people, but some lesions, not easily detectable, closely resemble those seen in a variety of human diseases. These include: (a) deposition of calcium salts into the arteries (arteriosclerosis), the lining of the heart, the heart muscle, the kidneys, and other soft tissues; (b) a weakening of the heart muscles; (c) a weakening of the leg muscles and tendons; and (d) an increase in the cholesterol level of the blood and a deposition of fatty material in the heart valves.

It has been presumed that these changes in experimental animals have been entirely due to a low level of magnesium in an otherwise adequate diet. Recent experiments, however, have shown that the level of magnesium is not the only consideration, for other constituents of the diet or conditions of the experiment can greatly modify an animal's requirement.

These are some of the results that have been obtained with experimental animals: The rat's requirement for magnesium was increased 6 to 8 times when extra fat, cholesterol, and cholic acid were added to the diet. A 4-fold increase occurred when the environmental temperature dropped from 78° to 55° F. A high protein intake required a higher intake of magnesium for normal growth. When rabbits were fed large amounts of calcium or phosphorus, together with small amounts of magnesium, 25 times more calcium was deposited in the kidneys than is normal.

Home economists are particularly interested in these interrelationships. They want to know if variations in the human diet can increase the requirement for magnesium to the point that body tissues are in short supply of this mineral, even though intake would appear to be adequate.

As our study progresses, results will be reported from time to time in ILLINOIS RESEARCH. — *Julia O. Holmes and Beula McKey*

A Vertical Silage Elevator Is in Experimental Stage

Conventional blowers for filling upright silos require large power units and have definite height limitations. To meet the need for a more efficient and versatile means of filling upright silos, the Department of Agricultural Engineering has designed and tested a vertical elevator.

This elevator uses two continuous chains to which forked flights are attached at 10-inch intervals. At the lower or intake end of the elevator, these flights move upward at an angle of 45° from horizontal, so that the silage falls between successive flights and minimizes wedging and throw-out problems.

At the upper or exit end, centrifugal force throws the silage clear of the flights as they turn at the upper sprockets. The silage then falls freely down the distributor pipe into the silo.

Testing the vertical silage elevator recently designed by the Department of Agricultural Engineering.

Silage is fed into the elevator by either a separate hopper or a side delivery self-unloading wagon. If a separate hopper is used, it must have some means of limiting the rate of flow into the elevator. With the wagon, the feeding rate is easily controlled by the speed of the unloading.

A 5-horsepower, single phase, repulsion induction motor has been used to drive the elevator. A motor of this size can be used on many farms without major changes in wiring or transformers. The motor is mounted within the framework of the elevator, which eliminates the usual belt alignment and tightening problems. It is controlled by simple on-off electrical controls.

Performance tests have been conducted using both grass and legume silage. In trials with field-chopped alfalfa elevated to 40 feet, rates of 23 tons per hour were obtained without completely loading the motor.

Last fall this elevator was used

to fill a 40-foot vertical silo with 72 tons of corn silage. Rates of 20 to 23 tons per hour were recorded; these were rather low because the corn silage was dry and fluffy. Power consumption averaged 0.183 kilowatt hour per ton, or at 2½ cents per kilowatt hour, less than ½ cent per ton.

The elevator may be easily towed by tractor from one place to another. Using the tractor power-take-off to operate the lifting winch, two men can erect the elevator in 30 minutes.

As this elevator is an experimental unit, none are at present available commercially. Experimental work is still being done to determine if the unit can be used for handling grain as well as silage. — *Floyd L. Herum*

How to Care for Your Christmas Tree

Eleven quarts of water will keep your Christmas tree fresh, green, and fire-resistant during the coming holidays. That is the amount of water consumed by a 6-foot Norway spruce during 2 weeks in a warm, dry room. Its mate, which received no water, lost all its needles during the same period (see photograph).

Every Christmas we hear and read many suggestions for treating the tree with chemicals and waxes to help it keep its needles and to reduce the fire hazard. Many of these treatments are unsatisfactory for home use. Most people will find the water treatment superior.

Tree on the left received 11 quarts of water during 2 weeks in a warm, dry room. That on the right received none.

The tree will absorb water more freely if a fresh, cross or diagonal cut is made at the base of the stem before standing the tree in water.

Although fir and pine trees retain their needles much better than spruce, they too will benefit from the water treatment. — *Ralph W. Lorenz*

Debt-Paying Ability of Farmers in East-Southeast Illinois

With the expanded size of farm enterprises in recent years, more money has to be borrowed. Both borrower and lender are interested in the factors that affect a farmer's ability to pay his debts.

In east-southeast Illinois, size of farm and grain production per acre were found to be the most important factors affecting debt-paying ability. Where livestock provided a substantial part of the income, livestock units per acre and efficiency in feeding livestock were also important. Grain farms were $1,000 ahead of general farms, and $1,600 above livestock farms in debt-paying ability.

These findings resulted from a 1954-1956 study of farm records in Clay, Cumberland, Effingham, Fayette, Jasper, Marion, and Richland counties. This part of the state, sometimes known as the claypan area, has an average precipitation of 38 to 42 inches, with 20 to 25 inches from May through September. Although this amount of rainfall is adequate, the light-colored soils are low in water-holding capacity. Both rainfall and temperature are moderately to highly variable during the summer, causing considerable year-to-year variations in yields. The low yields in drouth years are not likely to be offset by correspondingly high prices, and income from crops fluctuates rather widely.

Seven factors affecting debt-paying ability were included in a multiple correlation analysis. They were ranked according to their importance, with these results:

	Rank on—			
Factor	*Grain farms*	*Live-stock farms*	*Gen-eral farms*	*All farms*
Grain production per acre.	1	3	2	2
No. of acres....	2	1	1	1
Livestock units per acre.....	3*	2	5*	4
Months of unpaid labor...	4*	6*	4*	5*
Livestock efficiency index.	5*	4	6*	3
Soil rating.....	6*	7*	7*	7*
Cash operating expenses per acre........	7*	5*	3	6*

* Importance of factor relatively insignificant.

The unimportance of soil rating as a factor is due to the general uniformity of soils in the area. Soil rating would probably be important in a comparison between farms or areas having widely different ratings.

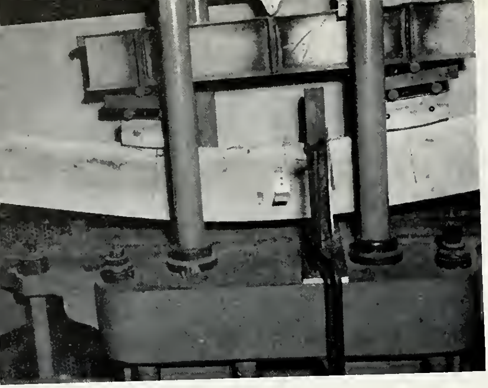
Other farming areas of the state will be studied to discover how differences in soil types, major farm enterprises, and climatic hazards affect debt-paying ability. — *G. L. Jordan and A. E. Holz*

Native Lumber Is Tested for Strength

How defects affect the strength of red oak and cottonwood beams is being studied by the Department of Forestry. Over 1,800 beams, ranging in size from 1″ x 1″ — 15″ to 2″ x 8″ — 8′, have been tested. Eight-foot 2 x 4's have also been tested.

Cottonwood was selected for study because it is commercially important in Illinois but is usually considered too weak for framing in farm structures. Red oak is abundant in Illinois and is used extensively for farm construction.

The beams were bent in a testing machine somewhat as joists would be bent by a heavily loaded barn floor. Each beam was bent until it broke. The influence of such defects as knots, crossgrain, bark pockets,



The testing machine applied a load of 12,050 pounds to this red oak beam before it broke. At failure the beam had bent 4 inches.

worm holes, splits, and checks on the strength of the beams was recorded. Some 8-foot 2 x 8 cottonwood beams were as strong as some of the red oak beams.

Information obtained in the study will be used to develop a system of classifying native hardwood lumber for construction purposes. Such a system will enable the buyer to select lumber strong enough to fit his needs, and will help the producer to sort and price lumber sold for structural use. — *J. K. Guiher*

Prolonging the Viability of Spores of Wheat Loose Smut

Refrigeration seems to be the answer to the problem of maintaining viability in spores of loose smut (*Ustilago tritici* (Pers.) Rostr.). Up to now there has been no completely satisfactory way to keep the spores alive for more than a few months. As a result, it's been difficult to carry on physiologic race studies or to evaluate the resistance of wheat hybrids to specific races of the organism.

The usual technique for maintaining viable cultures has been to store the infected seed of the host plant. This has not been entirely satisfactory because it risks contamination or mutation within a given smut culture.

The lyophile process has been used to prolong the viability of these spores (S. O. Graham, Washington Agricultural Experiment Station, Scientific Paper No. 1483). This process is not easy to apply, however, and may not be readily available for all who need it.

In the Department of Plant Pathology, dry spores of four different races were placed in separate airtight glass vials and stored at 36° to 38° F. in a refrigerator. Special care was taken to use only dry spores, because moist ones tend to become covered with a saprophytic fungus growth and lose viability rapidly.

Germination tests were made periodically for 9 years. At the end of this time 10 to 40 percent of the spores germinated. Pathogenicity tests were also made by inoculating wheat flowers with a spore suspension consisting of the spores plus water containing 1 percent of malt extract. Excellent infection resulted, indicating that the spores had not lost the factor for infection during the 9 years.

It can be concluded, therefore, that lyophilization or other special techniques for maintaining the viability of loose smut spores is unnecessary under ordinary circumstances. Nine years should be enough time to complete most any experiment that requires viable spores of the original culture. — *Wayne M. Bever*

How to Avoid Ammonia Losses When Using a Moldboard Plow Applicator

If proper techniques are followed, anhydrous ammonia can be safely applied with a moldboard plow applicator. During the past year, the Department of Agricultural Engineering has determined that losses of volatile ammonia will be negligible provided the following conditions are met:

1. **Soil must be in normal plowable condition.** Losses increase if the soil is extremely wet or extremely dry.

2. **The release hose must be attached so that ammonia is placed deep enough and far enough from furrow walls.** Ammonia losses were measured after applications were made with the release hose in varying positions. Results showed that ammonia should be placed 6 inches deep or more to avoid excessive losses. Hoses should be attached to the plow so that they are trailed under the furrow slice at least 4 inches from the furrow wall. They should also be long enough to release the ammonia back of the zone of soil turbulence created by the moldboard inversion.

3. **Soil should be completely inverted by the moldboard.** An even plowing operation will help to seal the ammonia in the soil and to prevent excessive losses. A plowed soil which has well-defined cleavage between the furrow slices gives the ammonia a direct escape route to the atmosphere. — *M. R. Smith*

Antibiotics in Soil

Despite the extensive use of antibiotics for the cure of human, animal, and plant disease, the production of these chemicals by soil microbes certainly was not meant for this purpose. Why, then, are such compounds produced? One possibility is that the formation of antibiotics in the soil would kill some bacteria and fungi, thus permitting other, beneficial organisms to fight for food and living space.

Although we have never been able to prove the presence of even one antibiotic in natural soil, there is much indirect evidence that microbes do manufacture antibiotics in soil. When we added an antibiotic-producing microbe to sterilized soil in the laboratory, antibiotics were sometimes produced. At other times,

specific organic fertilizers were necessary for the synthesis of such compounds. In some experiments, antibiotics were produced even in unsterilized soil after fertilization with green manure. There is still another type of evidence for the formation of antibiotics in soil: When a fungus that inhibits the growth of pathogenic fungi is added to the soil, the amount of disease caused by those pathogens is often reduced.

Even if antibiotics were produced naturally in the soil, they might not prevent the growth of their competitors, for laboratory experiments have shown that these substances have a very precarious existence. Some can be absorbed by clay and organic matter. Others are so unstable that they are inactivated by air. A large number are broken down by the natural microbial population of soil, and we can even identify the microbes responsible for this degradation. The acidity or alkalinity of the soil also influences the stability of specific antibiotics. Many factors then could explain why we have failed to find these substances in natural soil.

Despite our lack of success thus far, the search for antibiotics in the soil still goes on. One reason is that we have no other facts to explain the indirect evidence of their existence. Furthermore, proof that antibiotics are produced in soil might help us to explain differences in microbial populations, such as the presence or absence of Azotobacter, the nitrogen-fixing bacteria. The synthesis of antibiotics has even been suggested as the reason why pine trees do not grow in certain areas of England: These chemicals are supposed to stop the growth of fungi that are beneficial to the pines.

Finally, if we can show that microbes produce antibiotics in soil and that these chemicals prevent the growth of fungi and bacteria which cause plant diseases, then we can reasonably add antibiotic-producing organisms to soil to control disease. Under these circumstances one can visualize using them somewhat as we now use fertilizers.—*David Gottlieb*

Methods of Selecting Meat-Type Animals Are Studied

The Department of Animal Science is currently conducting research to find methods of measuring characteristics associated with a high proportion of lean meat in beef cattle, hogs, and lambs. If successful, the studies will lead to inexpensive, and, above all, accurate appraisal of meat-type characteristics.

At present, the measurements are being validated on the carcass. The end objective, however, includes the development of criteria that can be applied to the living animal. The establishment of such criteria will not only provide much-needed tools for nutritional, management, breeding, and physiological studies, but will also provide some bases for on-the-farm selection of breeding stock for meat characteristics. — *B. C. Breidenstein*

COMING EVENTS

(A partial list of meetings scheduled at Urbana)

Oct. 15-16: Fortieth Annual Illinois Conference and Extension Short Course for Veterinarians

Oct. 17: Homecoming

Oct. 17: Home Economics Open House for Alumnae

Oct. 30: Sheep Day

Nov. 5: Florists' Short Course

Dec. 3: Farm Structures Day

Agricultural Industries Curriculum Gives Students New Opportunities

HAROLD W. HANNAH

Beginning this fall, students in the College of Agriculture can enroll in a new curriculum. This is the agricultural industries curriculum, which combines business training and agriculture. Many other agricultural colleges have developed similar programs.

The need for these programs stems from the fact that nearly one-half of all agricultural college graduates are employed in some kind of business — usually a business related to agriculture. Of a total labor force of more than 62 million, an estimated 10 million are on farms and about 15 million are in businesses which produce for or serve farmers, or which process and distribute farm products.

Agricultural businesses can be roughly divided into four main groups: farm supplies, agricultural commodities, food and food products, and agricultural real estate and finance. The agricultural industries curriculum is designed to prepare people for work in one of these areas. Through a faculty advisory system, students are guided into the area which seems best suited to their interests and abilities.

Besides courses in the College of Agriculture, the new curriculum requires at least 26 hours of course work in the College of Commerce and Business Administration. These courses include accountancy, business law, economics, finance, management, and marketing. Communications courses such as rhetoric, speech, and journalism are also required. In addition, students may choose courses in other areas to help round out their education and to give them a better background for the type of work they have chosen.

Harold W. Hannah resigned as Associate Dean of the College on August 1. At present he is in India, helping to establish the new U. P. Agricultural University. Upon his return he will teach agricultural law.

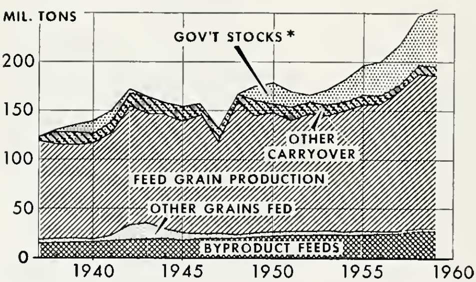
FARM BUSINESS TRENDS

Feed Grains. Production of feed grains in 1959 will be at a record high, and 5 to 10 percent above prospective use. Hence carryover will increase next year, even though feed grain use has risen sharply in the last two seasons and — judging from the present build-up in livestock numbers — will increase still more in 1959-60.

Most of the increase in prospective 1960 carryover will be in corn. Because all farmers with approved storage will be eligible for the $1.12 price support (which is 6 cents higher than last year) a big percentage of the corn carryover will go into government stocks. The size of these stocks in recent years is shown in the chart below.

Wheat. There is no surplus of soft red winter wheat, but we have enough hard red winter wheat to last for 2 years. Prices of hard red winter may rise a little, but the soft red winter seems to have the best chance to pay its storage costs and return a profit.

FEED CONCENTRATE SUPPLY



1959 BASED ON JULY 1 INDICATIONS
*UNDER LOAN OR OWNED BY CCC
CORN AND SORGHUM GRAINS OCT. 1, OATS AND BARLEY JULY 1

According to September 1 figures, the 1959-60 feed concentrate supply will be larger than the July 1 indications given in this chart. Prospective feed grain production for 1959 is 166 million tons — 8 million more than in 1958. A substantially larger corn crop more than offsets smaller crops of oats, barley, and sorghum grains.

Soybeans. Carryover of old beans on October 1 was around 50 million bushels. This was well above the previous record of 21 million set last fall, but it was only about half as much as some forecasters expected when the 1958 crop was harvested.

The 1959 crop will probably be around 530 million bushels, 7 percent less than last year. Total supply — carryover plus crop — may be 10 to 20 million less than in the past marketing year. Practically all this supply will be used before the next crop is harvested. Thus, if there is a serious price decline at harvest time this fall, an important price increase is possible later.

Beef Cattle. The total 1959 calf crop is officially estimated at 41.3 million head. This is only 2 percent more than last year, and 3 percent short of the record set 5 years ago. But we calculate that the number of beef type calves is about 22.9 million head, 8 percent more than last year, and 3 percent more than the previous record beef calf crop in 1955.

Range and pasture conditions are generally good. Slaughter of cows and calves continues quite small. Thus the build-up in numbers seems likely to continue for another year. Prices of slaughter cattle should hold up fairly well for another 12 months or so, but farmers may bid up the prices of feeder cattle to excessive levels.

Hogs. Marketings of hogs may be relatively large in the early fall, and increase only a little later. This was indicated by the June Pig Crop Report. The number of 3-to-6-month old pigs on farms was 15 percent greater on June 1 than at the same time last year. But the number under 3 months was up only 5 percent. Most of the older pigs should be gone by the end of September. It appears quite possible that hog prices will decline less than usual this fall. If this is so, the winter recovery will be very limited. In June, farmers reported intentions to breed 9 percent more sows for fall pigs than they bred last year.

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Winter, 1960

ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

IN THIS ISSUE

Lumber rigid frames may revolutionize the construction of farm buildings (page 6).

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ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

CONTENTS

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Louis B. Howard . . . . Dean and Director
Tom S. Hamilton . . . . Associate Director
Adrian Janes . . . . Station Editor
Margery E. Suhre . . Editor, ILLINOIS RESEARCH

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THE DEPARTMENT OF AGRICULTURAL ECONOMICS

is concerned with the business or financial side of farm production, marketing, and processing. It encompasses several subject-matter areas, including farm management and production economics, marketing, rural sociology, prices and statistics, agricultural finance, public policy, and agricultural law.

The department offers a complete teaching program, from beginning courses through advanced courses leading to a Ph.D. degree. Graduates have a broad choice for careers in agricultural industry, government, university service, farming, foreign service, and other occupations.

Research in agricultural economics includes analyses of all types of agricultural business, starting with the farm and extending through the whole structure of marketing farm products to the final consumer. Agricultural prices, sound credit practices, and the efficiency of various combinations of farm enterprises are among topics studied.

Much that is found out in research is used in extension programs that reach large numbers of farmers. Each year more than 200 meetings are held throughout the state on the outlook for farm prices and markets. The department also publishes a weekly outlook letter. More than 5,000 farmers receive individual counseling through the Farm Bureau Farm Management Service, which receives professional leadership from the department. This is the most successful program of its kind in any state. A new service of the department, "Economics for Agriculture," will give timely information to leaders in Illinois. The department also sponsors conferences for farmers, bankers, and leaders in agricultural industries.
— *Harold G. Halcrow, Head of the Department*

Dr. Halcrow has been Head of the Department of Agricultural Economics since September 1, 1957, having previously been at the University of Connecticut and Montana State College. He received his Ph.D. in economics from the University of Chicago in 1948. He is the author of two books, as well as many bulletins and articles, and is co-author of a third book. From 1955 through 1957, he edited the Journal of Farm Economics.

For best yields

GROW SOYBEANS in NARROW ROWS

J. W. PENDLETON, R. L. BERNARD, and H. H. HADLEY

This is the space age, but we are not being space-conscious when we grow soybeans in 40-inch rows.

Many years ago, when soybeans first came into the corn belt, Illinois agronomists showed that optimum yields were obtained from narrow row spacings. However, the ease with which soybeans could be planted and cultivated with corn equipment led most farmers to use 40-inch row spacings. In the 1930's, when this practice was started, soybeans were still a minor crop in Illinois. Today, however, they are a major crop, accounting for a large share of total farm income. Progressive farmers are therefore seeking new ways of increasing production.

In 1958 the authors decided to take another look at narrow row culture. We wondered how present-day varieties, differing in height, maturity, and lodging, would respond to planting in narrow rows. Would results be the same for different planting dates and at different locations? These variables were included in extensive experiments during the past two seasons.

Yields of Different Varieties

Different varieties responded to row spacings in much the same manner. All varieties yielded the highest at 24-inch row spacings and the lowest at 40-inch spacings (Fig. 2). This occurred in spite of a great difference in maturity and plant height. Chippewa, for example, matures about a month earlier than Clark and is at least a foot shorter.

Location and Weather

In 1959, an advantage for 24-inch rows over 40-inch rows occurred on the three Agronomy Research centers located at DeKalb in northern Illinois, Urbana in central Illinois, and Brownstown in southern Illinois (Fig. 2). These locations differ not only in latitude but also in soil type. The Brownstown field is located on a claypan soil while the other two are on dark prairie soils.

The two recent growing seasons at Urbana have been distinctly different. In 1958, rainfall favored soybean production, but in 1959 June and July were unusually dry. Yet the yield response to narrow rows was similar for the two seasons.

Planting Date

Since early-planted soybeans usually grow taller than those planted late, we thought that optimum row spacings might depend partly on planting date. This seemed not to

J. W. Pendleton examines a soybean plant on one of the narrow-row research plots. Dr. Pendleton is Associate Professor of Crop Production at the University, and H. H. Hadley is Associate Professor of Plant Genetics. R. L. Bernard is Research Agronomist at the U. S. Regional Soybean Laboratory in Urbana.

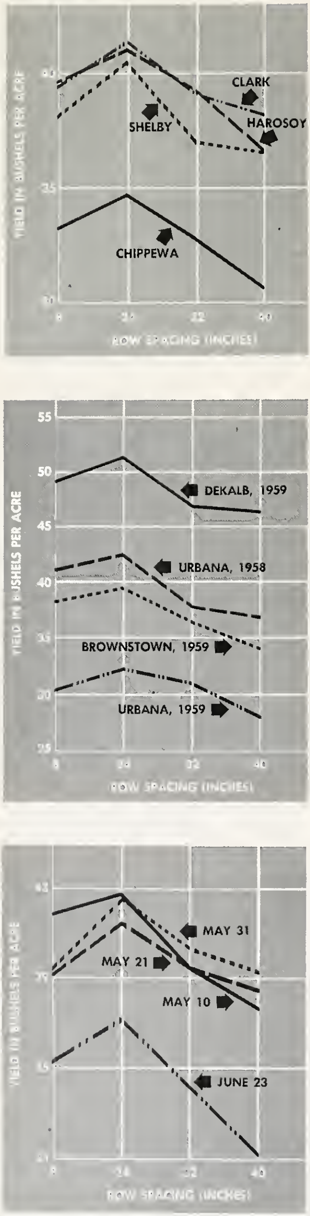
be the case, however. In Figure 2, the curves showing yields for four planting dates are almost parallel to one another.

A 15-Percent Yield Increase

The most amazing aspect of the work thus far has been the consistency with which narrow rows have outyielded the 40-inch rows. Considering all results from 352 individual plots, the yield advantage for 24-inch rows over 40-inch rows has been about 15 percent. At a 40-bushel yield level, this would be 6 additional bushels. At the average Illinois production of 25 bushels, narrow rows could add almost 4 bushels per acre.

In these research plots the soybean plants were carefully cut at ground level. Had they been cut at combine height, the yield difference in favor of narrow rows would probably have been greater. It was often observed that plants in the 40-inch rows podded lower than those in 24-inch rows. With usual harvest methods,

For more soybeans per acre, grow more rows per acre. Combining four 24-inch rows (as at left) instead of three 40-inch rows means more beans in the hopper. (Fig. 1)



How variety (top), location (center), and planting date (bottom) affected yields of soybeans grown in different row spacings. (Fig. 4)

therefore, more beans would have been left in fields where rows were wide.

Effects of Row Width on Other Characteristics

No great difference was noted in standability between 24-, 32-, or 40-inch row spacings, but some 8-inch plots lodged badly.

The effects of row spacings on plant height depend on rainfall. With plenty of moisture, plants in narrow rows tend to be taller than those in 40-inch rows. Under dry conditions such as occurred in 1959, the height of the plant increases with the width of the row.

Differences in row spacings did not noticeably affect quality or chemical composition of the seeds.

Seeding Rates

In these trials, seeding rates were increased as row spacings decreased. Rates in pounds per acre were: 40-inch rows, 50; 32-inch, 62.5; 24-inch, 75; 8-inch, 100. These rates make for close, even distribution of plants in the row and thereby help to control weeds.

In a 1959 planting rate trial at Urbana, however, weed-free 24-inch rows yielded very nearly the same whether the seeding rate was 60, 75, 90, or 105 pounds per acre. Under similar weed-free conditions, yields from 8-inch rows were not improved by increasing the seeding rate over 80 pounds.

Weed Control Important

One cannot hope for a weedy field of narrow rows to out-produce a weed-free field of standard rows. Early weeds need to be controlled as thoroughly in narrow rows as in wide ones. Late-germinating weeds are generally less of a problem in narrow rows than in wide rows because the ground surface is better shaded in the narrow rows.

At present it's difficult to control weeds in 8-inch rows, because cultivation has to be done with a rotary hoe. In the tests reported here, some weeds were in the 8-inch rows, while the other rows were nearly weed-free. Even so, the 8-inch rows generally yielded more than the 40-inch rows. Without weeds, they might yield as well as or better than 24-inch rows. If and when more effective and cheaper chemical weed killers become available, drilling soybeans in 8-inch rows might well become the most economical method of production.

Retooling Necessary

To grow soybeans in narrow rows, farmers will have to retool or gear up some of their machinery. Some growers have already done this. For planting, they use a grain drill with certain holes stopped up, a regular bean or beet planter, or an altered corn planter. For cultivation, they use regular cultivators available from implement dealers or they fashion their own. They do not usually try to adjust one cultivator for use on both corn and soybeans.

Growers with small acreages should perhaps hesitate to change their equipment. Those with large acreages, however, can make equipment changes pay off. An increase of 4 bushels per acre for 100 acres would mean about $800 extra income to cover costs of the changes.

All in all, the surest way to get more soybeans per acre is simply to grow more rows per acre.

Some growers are using large tractor equipment in narrow-row fields. On this Illinois farm, soybeans have been grown in 21-inch rows for 22 years. (Fig. 3)

New PAPER MULCHES Increase Vegetable Yields


Special machines have been developed to lay paper mulches.

NORMAN F. OEBKER and J. WILSON COURTER

FOR MANY YEARS it has been known that mulching controls weeds and increases the yields of certain vegetables. Now recent developments are arousing new interest in this old gardening practice. Black plastic (polyethylene) has been introduced for mulching, and improvements have been made in paper mulches.

As long ago as the early thirties, paper was tried as a mulch on vegetables, but it deteriorated before harvesting was finished. The improved kraft paper mulch now available contains a fungicide which keeps the paper from breaking down before the end of the season. No molds or other fungi will grow on this paper. Starting this year, dieldrin will be added to the paper for insect control. Since we have not tried any paper with dieldrin, we do not know how effective it will be.

Mulches Tested

To evaluate the new paper mulch under Illinois conditions, we tested it on cucumbers planted at Urbana in 1958 and 1959. Black plastic and ordinary cultivation were also included in the experiment.

The first year a strip of black plastic (33 inches wide and 1.5 mils thick) and a strip of brown mulch paper (33 inches wide and 60 pound weight) were laid over the well-prepared seedbed and were held in place by covering the edges with soil. The second year a similar experiment was carried out, but the plastic and paper were 40 inches wide and the paper was only 30 pound weight. The seeds were planted through holes cut into the center of the mulch. Rows were 6 feet apart. Plantings were made during the first week of June in both years.

As shown in the table, both mulches boosted yields much above those obtained with ordinary cultivation, although all yields were very low in 1959 because of late planting and very dry weather. Earlier plantings would probably have given even larger differences in favor of mulches, especially during the very dry 1959 season.

Mulching saved a great deal of time because little weeding and no hoeing were needed in the row. The space between rows was cultivated with a tractor.

In some commercial fields where the paper was tested, enough light passed through the brown 30 pound paper to permit weed growth. A black 30 pound paper was therefore tried. No weeds grew under this paper, and it looked promising for future use. The 60 pound brown paper also kept weeds from growing.

Yield of Ashley Cucumbers in Mulching Experiments at Urbana

Treatment	Acre yield (bu. of U. S. No. 1's) Early	Total
1958		
No mulch	126	418
Black plastic	267	632
Paper	302	661
1959		
No mulch	36	52
Black plastic	83	114
Paper	69	99

Advantages and Disadvantages of Paper Compared With Plastic

Both plastic and paper mulches offer many of the same benefits: They control weeds, conserve water, keep fruits clean, warm the soil in spring, prevent leaching of nutrients, and maintain good physical condition in the soil. Another advantage is that both can be applied with a tractor-attached applicator.

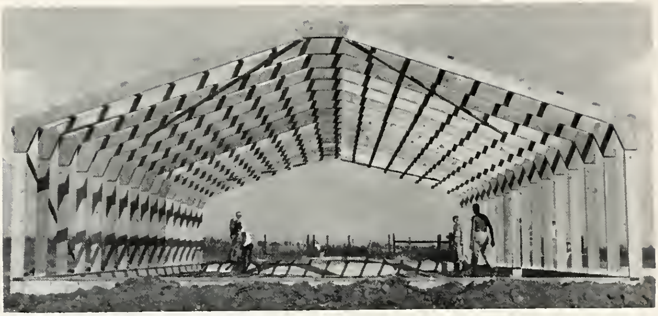
The new paper mulch, however, has two advantages over the plastic: It costs less and it's easier to dispose of at the end of the season. Paper can be plowed under without interfering with the following crop, but plastic has to be removed from the field.

The main disadvantage of paper is that it tears much easier than plastic. If it is laid carefully, however, and if the seedbed is smooth, this problem can be overcome.

Best Uses of Paper Mulch

The new paper mulch can be successfully used with tomatoes and other warm-season crops. At present, however, we feel that it shows more promise for commercial use in vine crops (cucumbers, muskmelons, squash, and watermelons). These crops respond well to mulching, and planting can possibly be mechanized when paper is used. Agricultural engineers are now working on a planter that will be attached to the paper-laying machine and will plant seeds directly through the paper. If this planter develops, we believe that many acres of cucumbers, melons, and squash will be planted on paper mulch in Illinois.

Norman F. Oebker is Associate Professor of Horticulture, and J. Wilson Courter is Instructor of Horticulture.



Something New in Farm Buildings:

LUMBER RIGID FRAMES

J. O. CURTIS and E. L. HANSEN

A NEW BUILDING FRAME that may revolutionize the construction of farm buildings has been made possible through research in the Department of Agricultural Engineering.

The frame is made of lumber. It consists of two studs and two rafters made rigid by plywood gussets glued and nailed on each side of each angle. By doing away with the need for such interior obstructions as ties and posts, the rigid frame provides more usable space than do the conventional methods of construction. It is also cheaper: Frames can be made at home or by local lumber yards or builders, and they can be erected quickly and easily.

E. L. Hansen, Professor of Agricultural Engineering, and J. O. Curtis, Assistant Professor of Agricultural Engineering, are applying a load to a building frame and measuring deflection. Frames were tested lying on a testing floor and the load was applied with hydraulic cylinders.

The idea of the rigid frame was first tried on a small swine shelter in 1957. In designing the framing for this building, accepted procedures of structural analysis were used to determine stresses in members. No established procedure could be found, however, for designing the nailed and glued plywood gussets, which were subjected primarily to a bending load. Research was therefore undertaken to develop such a procedure.

Series of Joints Tested

Load tests were made on a series of 88 full-scale joints formed with nailed and glued plywood gussets. Results of this research were used in designing complete building frames.

Joints were made out of construction grade Douglas fir, C-C exterior sheathing grade Douglas fir plywood, and grade A casein glue. Nails were used to apply pressure while the glue set.

Five sizes of framing lumber were included in the tests: 2 x 4, 2 x 6, 2 x 8, 2 x 10, and 2 x 12. Two thicknesses of plywood were tried for the gussets — ⅜ inch and ⅝ inch. Other variables were size of gusset and orientation of grain of the face plies of the gusset.

Loads and Stresses

To design a series of rigid frames, the following loads were assumed:

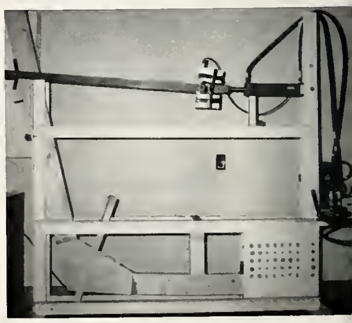
1. A combined snow load and dead load of 25 pounds per square foot of horizontal projection of the roof surface.

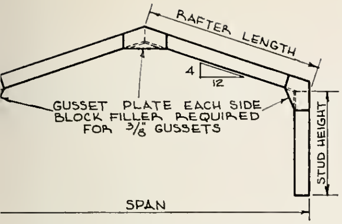
2. A wind velocity pressure of 20 pounds per square foot at a height of 30 feet. This is equivalent to a wind velocity of 88 miles an hour at this height. A correction was then applied for the actual height of the building. The frames were designed for a load resulting from the wind blowing toward the open side of a building closed on the other three sides.

The following allowable working stresses were also assumed:

1. A stress in extreme fibre in bending of 2,000 pounds per square inch.

Equipment used in making load tests on the joints. A hydraulic cylinder is exerting pull on the rafter member and producing compression in the unsupported edge of the gusset. (Fig. 1)





Typical layout of a rigid frame. (Fig. 2)

2. A stress in compression parallel to the grain of the lumber of 1,600 pounds per square inch.

3. A stress in shear parallel to the glue line of the plywood of 90 pounds per square inch.

Recommendations for Rigid Frame Designs

A whole series of lumber rigid frame designs are presented in the table. Lumber size varies from 2 x 4 to 2 x 12, the span varies from 12 to 40 feet, and the stud height from 6 to 12 feet. The table shows the spacing of the frames for combinations of the above conditions.

The general pattern of the frames is shown in Figure 2. Details of the plywood gussets required for the various sizes of lumber members are given in Figure 3.

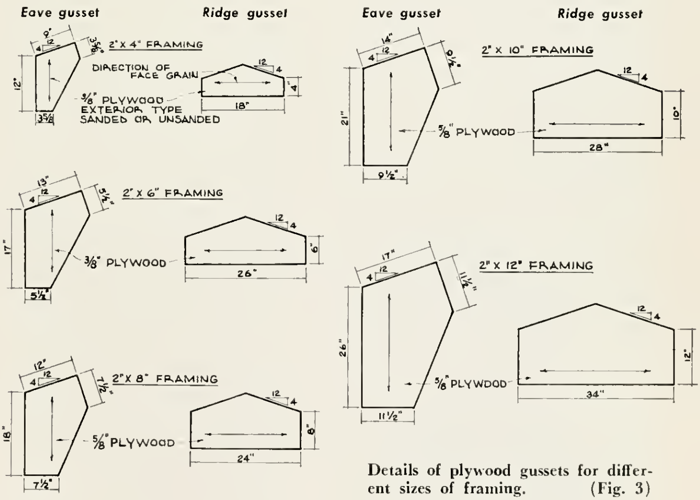
Kinds of Glue

Glue must be carefully selected so that it will be suitable for use under farm-type construction conditions. It must set at normal air temperatures, give strong joints when only nail pressure is applied, and be reasonably easy to use.

Two basic types of glue satisfy the above requirements. They are Grade A casein glue and resorcinol-resin glue. The choice between these two glues depends on how much resistance to moisture is required. Resorcinol-resin glue is waterproof. It should be used in making frames that will be subjected to damp conditions. Grade A casein glue is water resistant, and can be used when a waterproof glue is not needed.

Maximum Spacing of Frame

Framing member	Side-wall height, feet	Maximum spacing when span is —							
		12 ft.	16 ft.	20 ft.	24 ft.	28 ft.	32 ft.	36 ft.	40 ft.
2 x 4	6	3′–8″	2′–0″	1′–2″					
	8	2′–8″	1′–10″	1′–2″					
	10	2′–0″	1′–6″	1′–2″					
	12	1′–8″	1′–4″	1′–0″					
2 x 6	6	9′–2″	5′–0″	3′–2″	2′–2″	1′–6″	1′–2″		
	8	6′–6″	4′–8″	2′–10″	2′–2″	1′–6″	1′–2″		
	10	5′–4″	3′–10″	2′–10″	2′–0″	1′–4″	1′–0″		
	12	4′–2″	3′–4″	2′–6″	1′–10″	1′–4″	1′–0″		
2 x 8	6	13′–4″	8′–8″	5′–6″	4′–6″	2′–10″	2′–2″	1′–10″	1′–6″
	8	11′–10″	8′–0″	5′–2″	3′–6″	2′–6″	2′–0″	1′–6″	1′–4″
	10	9′–2″	6′–10″	5′–0″	3′–4″	2′–6″	1′–10″	1′–6″	1′–2″
	12	7′–2″	5′–8″	4′–4″	3′–4″	2′–4″	1′–10″	1′–6″	1′–2″
2 x 10	6		14′–6″	9′–0″	6′–4″	4′–8″	3′–8″	3′–0″	2′–6″
	8		13′–0″	8′–2″	6′–0″	4′–2″	3′–2″	2′–8″	2′–2″
	10		10′–10″	8′–0″	5′–6″	4′–0″	3′–0″	2′–6″	2′–0″
	12		9′–2″	7′–0″	5′–4″	3′–10″	3′–0″	2′–4″	2′–0″
2 x 12	6			13′–6″	9′–6″	7′–2″	5′–6″	4′–6″	3′–8″
	8			12′–4″	8′–6″	6′–4″	4′–10″	4′–0″	3′–4″
	10			11′–10″	8′–2″	6′–2″	4′–6″	3′–8″	3′–0″
	12			10′–4″	8′–0″	5′–10″	4′–6″	3′–6″	3′–0″



Details of plywood gussets for different sizes of framing. (Fig. 3)

Nails

Nails are used to put pressure on the glued surfaces. A row of nails should be located about ¾ inch from the edge of the gussets and members, and approximately 3 inches apart otherwise. Nails should be 4-penny for ⅜ inch plywood gussets, and 6-penny for ⅝ inch gussets.

More Information

Illinois Extension Circular 812, "Lumber Rigid Frames for Farm Buildings," gives construction details. To obtain it, write to the Information Office, 112 Mumford Hall, University of Illinois, Urbana. A new bulletin, containing details of the research, will be available soon.

Uses and Limitations of

THE CHEMICAL ANALYSIS OF FEEDS

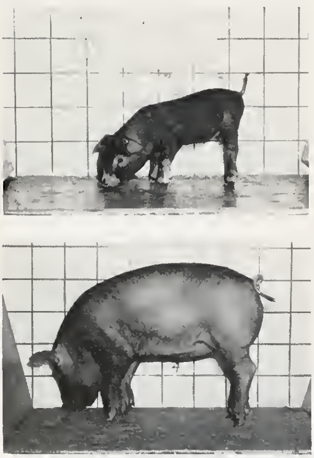
In the evaluation of animal rations, "the proof of the pudding is in the eating"

J. KASTELIC, author of this article, is Head of the Division of Animal Nutrition. He came to Illinois in 1956 from Iowa State University, where he did meats research in the food technology laboratory.

THE ACHIEVEMENTS of chemical research laboratories throughout the world have been most remarkable. As a result, chemistry has become so generally accepted in our everyday lives that we sometimes forget its limitations. Certainly no hint of these limitations is given by the white-coated, persuasive actor holding test tubes or standing transfixed before a maze of laboratory apparatus that is now the hallmark of product advertising shown on our television screens.

It is not surprising, therefore, that the Department of Animal Science is often deluged with boxes, bottles, and bags of feed, all accompanied by the request, "Please analyze." Unfortunately, these requests are not so simple as they may seem. For chemistry does have its limitations, and chemical analysis alone will not tell a person all he wants to know about a sample of feed.

What, then, do we learn from chemical analysis? The purpose of this article is to tell something of both the value and the limitations of laboratory analysis of feeds.



At top is a pig that had been without vitamin B_{12} for 7 weeks. At bottom is the same pig after receiving vitamin B_{12} for 6 weeks. The two rations would have appeared very similar on the basis of proximate analysis. (Taken from research done in the Division of Animal Nutrition by Dr. B. C. Johnson.) (Fig. 1)

Proximate Analysis Used in Nutrition Research

Many attempts have been made to devise a simple scheme of chemical analysis for use in nutrition research. The scheme now used is based on one that was developed in Germany more than a hundred years ago.

It is a system of proximate analysis — that is, it determines only the six proximate principles (main compounds or groups of compounds) in a feed. These are water, ether extract, crude fiber, crude protein, ash, and nitrogen free extract.

This system is the best that has been devised for standardizing ration formulations and classifying a feed into its proper category. It is therefore used in many animal feeding experiments at this and other universities.

If we know the ingredients of a ration and know that it has been handled properly, proximate analysis can be very valuable. It can help us decide whether the ration will probably be suitable for a particular animal and a particular purpose. We can do this, however, only because of experience gained from actual feeding trials. That is, we have learned to associate the performance of animals with certain properties determined by proximate analysis. Even with this background of experience, we have to actually feed a new ration before we can be sure that the tentative judgment based on proximate analysis is correct.

Regulatory Uses

Because feeding trials have enabled us to correlate performance with the results of proximate analysis, this system is valuable in regulating the production and sale of commercial feeds.

Government agencies have specified maximum or minimum allowances for the percentages of crude fiber, crude protein, ether extract, ash, and water that a feed can contain. This information is therefore given on the label.

Since we can usually assume that feeds have been pretested and carefully formulated for a specific feeding purpose, the figures on the label are a useful index of a feed's probable value. This is not to suggest, however, that all manufactured feeds will result in maximum performance. Vitamin and mineral content, as well as other variables, need to be considered. It must be remembered that

the label on the bag is a statement of content and not of nutritive value.

Nutritional Value Not Measured

Proximate analysis was never intended as a means for analyzing individual nutrients. If we try to assess a ration's nutritional adequacy on the basis of proximate analysis we immediately run into difficulties.

The figure for crude protein, for example, while valuable for the regulatory and standardizing purposes already mentioned, doesn't help much in determining nutritional value. This figure is estimated by measuring the amount of ammonia nitrogen that is produced when a feed undergoes a rigorous digestion with boiling concentrated sulfuric acid in the presence of a catalyst. Since most proteins contain about 16 percent nitrogen, we multiply the ammonia nitrogen value by 6.25 to compute the amount of "protein."

Animal nutrition is a complex problem. (Fig. 2)

However, the ammonia produced by digestion with sulfuric acid need not represent protein per se. While most of this ammonia comes from the amino acids that make up the proteins, some of it will come from urea if this has been added to a feed.

Even if the crude protein figure represented protein content exactly, it wouldn't mean much unless the amino acid composition of the feed proteins were carefully considered. The different proteins in cereals and in protein supplements such as meat scrap, soybean, and fish meals contain varying amounts and combinations of the different amino acids. This variation is associated with wide variations in an animal's growth and ability to retain nitrogen, as has been demonstrated in feeding trials.

The problem in animal nutrition is therefore not merely a question of supplying a lot of protein. It is, rather, a question of studying the amino acid content of the various proteins. Through feeding trials we have learned that amino acid supplementation, or the mixing of two or more proteins, may improve the nutritional value of plant proteins for animals. More experiments are necessary to learn what ratios and proportions of the different proteins will permit the amino acids to supplement one another most effectively.

The figures for crude fiber, ether extract, nitrogen free extract, and ash require as much careful interpretation as those representing crude protein. None of them can be considered as representing specific quantities of individual nutrients.

Why We Don't Do Complete Analyses

By this time the reader may well be asking, "If proximate analysis wasn't designed to account for all the nutrients in a ration, why not use a different method? Why can't a complete chemical analysis be made? Why are feeding experiments always necessary to give us the final answers about a feed?"

One reason we do not attempt a complete analysis of an experimental ration is the expense involved. A chemical analysis of just the individual minerals and vitamins in an ordinary animal ration would cost more than $800 in a commercial laboratory. If we were to attempt an individual analysis for each of the 8 to 10 essential amino acids and the several kinds of fats and carbohydrates, as well as for vitamins and minerals, it would represent a heroic undertaking.

Even a complete chemical analysis would not give us all the information we need. In Figure 2 we see a very simplified description of the problem involved in determining the adequacy of a ration. Obviously, in nutrition research chemical analyses must always be coupled with studies of the biologic responses of the animal. Without such studies we cannot yet accurately predict the digestibility of the various fractions of feeds, or the efficiency with which the nutrients are absorbed and utilized. Nor can we explain all the variations in the response of animals to rations just on the basis of what we now know about the principles of nutrition.

"Please Analyze" A Difficult Request

The reasons why "Please analyze" is such a difficult request should now be obvious. In summary, the system of proximate analysis used in nutritional research can, at best, give us only a tentative judgment concerning the nutritional value of a feed. Even then, we need to know the ingredients of a feed, the way in which it has been handled, the class of livestock for which it is intended, and the purpose of feeding. A complete chemical analysis is very expensive and still does not tell us all we need to know.

The ultimate information can come only from actual feeding tests. It is a sobering reflection that in this day of great technological advances we must still depend upon animals to "tell us" whether a feed is good or bad.

INSECTICIDES on FORAGE CROPS

***Used carefully,** insecticides are a great boon*

***Used carelessly,** they are a danger to people and animals*

R. P. LINK, NORMAN GANNON, and G. C. DECKER

THANKS TO MODERN INSECTICIDES, our control of insects has greatly improved in recent years. As a result, the production of many crops has increased.

These blessings, however, are by no means unmixed. For compounds that can poison insects may also be poisonous to people and livestock.

Government agencies have therefore set up definite regulations as to the use of insecticides on crops. These regulations are devised to protect the health of man and animals, and provide a wide margin of safety. They do, however, permit limited amounts of certain insecticides to be on or in some foods. A person or animal can consume small amounts of most poisonous substances without harm.

Regulations Vary With Kind of Insecticide and Use of Crop

The amounts of insecticides that can be used on crops vary partly with the nature of the insecticide and its formulation. Some insecticides and formulations are stored in the body more easily than others.

Many of the newer materials are chlorinated hydrocarbons that dissolve in fats and oils. They are therefore stored in the fat tissues of an animal if it eats enough of them.

R. P. Link, Professor of Veterinary Physiology and Pharmacology, has been at the University 13 years. Norman Gannon was formerly with the Natural History Survey. G. C. Decker is Head of the Section of Economic Entomology at the Survey, and Professor of Entomology.

Some may appear in animal tissues if the animal just comes into contact with them under certain conditions. Others, however, are not easily absorbed, except in some formulations, and an animal may eat them in small amounts without any apparent danger of their being stored in the body or appearing in milk.

Added to this is the ability of most animals to metabolize variable amounts of "foreign" substances. Unless the amount consumed exceeds the amount that can be metabolized, none of the substance will remain in the body. This ability of the animal is often referred to as "tolerance."

In addition to kind and formulation of insecticide, the intended use of a crop helps determine the amount of insecticide that can be safely used. Meat fat, for example, can contain 7 parts per million of DDT or 3 parts per million of methoxychlor, according to government regulations. Milk, however, can contain absolutely no insecticide. Obviously, forage intended for dairy cattle can be sprayed only with extreme care.

How Much Insecticide Can Cows Consume?

Because of the strict regulations concerning milk, it is very important to know just how much insecticide can be safely applied to crops that are to be fed to dairy cows. In other words, how much insecticide can a cow eat without producing contaminated milk?

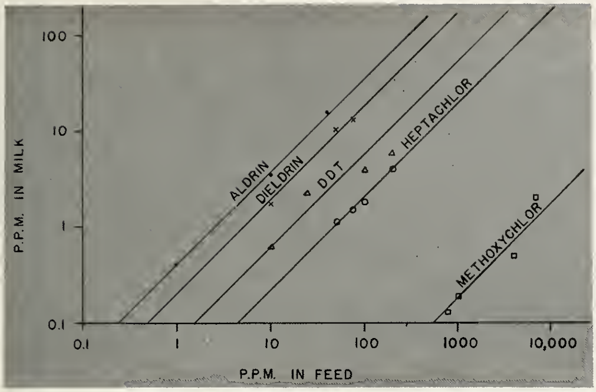
Experiments to help answer this question have recently been completed by the College of Veterinary Medicine and the Agricultural Experiment Station. In these experiments, lactating cows were fed grain and hay contaminated with known amounts of various insecticides. These insecticides were aldrin, dieldrin, heptachlor, DDT, and methoxychlor.

Several amounts of each insecticide were fed to different lots of cattle. The ranges in amounts (in parts per million) were as follows: aldrin, 0.10 — 40; dieldrin, 0.10 — 75; DDT, 0.10 — 200; heptachlor, 0.10 — 200; methoxychlor, 200 — 7,000. Most of the amounts fed greatly exceeded the amounts that would be found on forage sprayed and harvested under normal conditions. Insecticide residue rarely exceeds 0.10 part per million, and is often far less than that.

The amount of feed that each cow would eat in a day was treated with insecticide just before it was fed. This way, none of the insecticide was lost through evaporation, and the total amount ingested by each cow could be calculated. The rations were fed for 16 weeks.

None of the cows developed any signs of poisoning as the result of consuming the contaminated ration. Moreover, a comparison between these cows and similar cows fed a similar, uncontaminated ration indicated that there was no effect on feed consumption, milk production, or body weight. No differences were observed among the different cows.

Insecticide residues did not show up in the milk until after the contaminated rations had been fed for a while. It was to be expected that substances soluble in fats would appear in the milk if ingested in large enough amounts to be absorbed into



Relative amounts (in parts per million) of insecticides found in milk when cows consumed the insecticides at the indicated rates every day for 16 weeks. Lines on the chart were extrapolated from actual values obtained. (Fig. 1)

the blood and stored in the body tissues. Evidently, however, certain concentrations of most "foreign" substances must be in the tissues or the blood of a cow before they appear in the milk.

Apparently certain levels of heptachlor and methoxychlor could be in the daily ration without ever contaminating the milk. Methoxychlor residues did not appear until 640 parts per million were in the ration (Fig. 1). Heptachlor did not show up in the milk unless 4 parts per million or more were fed. DDT, aldrin, and dieldrin, however, appeared in the milk when less than 1 part per million was in the ration. The concentrations of aldrin and dieldrin were much higher than those of the other insecticides, when equal amounts were ingested.

The insecticides varied in the length of time that they persisted in the milk after the cows were taken off contaminated rations. DDT persisted the longest. Fatness of the cow appeared to influence both the amount of insecticide that appeared in the milk and its persistence after intake ceased.

Results of these studies indicate that aldrin and dieldrin should not be used on forage fed to dairy cattle, and DDT should be used only with extreme care. Heptachlor and methoxychlor, however, appeared to be relatively safe if reasonable care is exercised in their use.

Experiments With Dieldrin

Further studies were made with dieldrin to determine how much is stored in animal tissues and how long it remains in the tissues. Cattle, hogs, sheep, broiler chickens, and laying hens were fed rations containing given amounts of the insecticide. None of these species appeared to have much tolerance for dieldrin. Except for broilers, very small amounts in the ration resulted in considerable storage in the tissues (Fig. 2).

The amount of fat in the body was found to greatly influence the amount of dieldrin stored. Although the concentration of dieldrin was no greater in the fat of hogs than in the fat of steers, the total amount in a hog carcass was greater because of the greater total of fat.

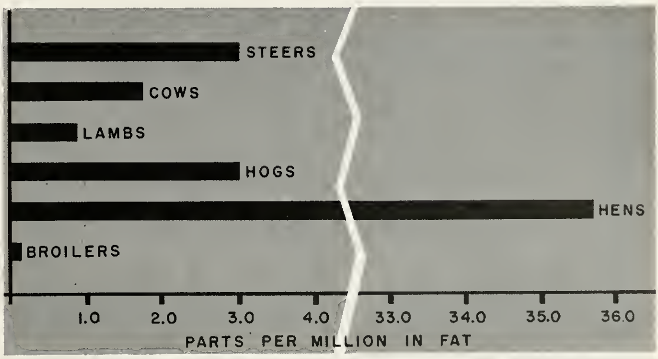
The broilers did not contain enough free fat to allow analysis for fat only. Data for broilers in Figure 2 are for fat and dark meat taken from the leg. The dark meat contained more dieldrin than the white meat.

There was a striking difference between the amount of dieldrin in fat from the hens and the amount in broiler tissue. Another unexpected finding was that there was no dieldrin in eggs laid by hens with very high dieldrin contents in their fat.

Recommendations Insure Safety

Even though the amounts of insecticides used in these studies were many times the amounts used for insect control, there was no evidence that they caused toxic reaction or loss in weight or production.

One can be assured that if pesticides are used on forage according to approved recommendations, they will not be a hazard to animal or human health, and they may be of great value in controlling the pests that damage or destroy crops.



Amounts of dieldrin stored in the fat of animals which had been fed rations contaminated with 0.75 part per million of dieldrin for 12 weeks. (Fig. 2)

FERTILIZER BULK-BLENDING

A Rapid Development in Illinois Agriculture

B. J. BOND

A RELATIVELY NEW method of manufacturing and marketing fertilizer has been making great headway in Illinois. This is bulk-blending, or the simple, non-chemical mixing of straight fertilizer materials in bulk. The blended product is usually not bagged and stored, but is spread on the fields immediately after mixing.

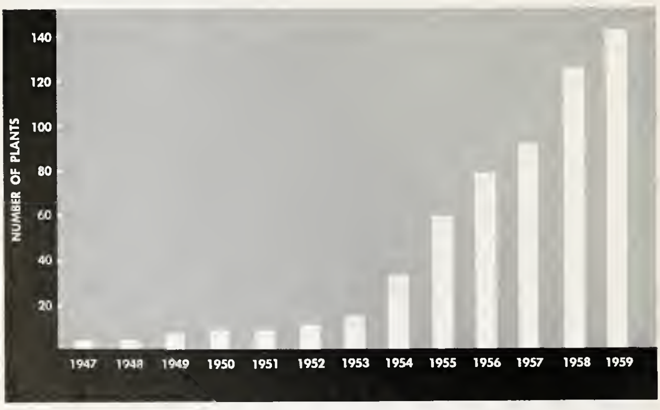
With this new development, a number of questions arose: What are the costs and outputs of bulk-blending plants? How does the price of bulk-blended fertilizers compare with that of conventional fertilizers? How much of the fertilizer sold in Illinois is bulk-blended?

The Department of Agricultural Economics, in cooperation with the Tennessee Valley Authority, accordingly undertook a study of Illinois bulk-blending plants in 1957. Some of the results are reported here. A more detailed account is given in Illinois Station Bulletin 632.

Growth and Importance

Bulk-blending originated in the midwest. The first blending plant in Illinois was built in Woodford county in 1947. Early growth was slow — by 1953 only 14 plants were operating in the state. Since then, however, the number of plants has increased rapidly. By now 142 plants are registered in Illinois, and more are being constructed. Bulk-blending is increasing in other midwestern states as well.

In 1956, 75 bulk-blending plants in Illinois sold 91,700 tons of straight material, excluding rock phosphate. Some of this was sold unblended, but 62,700 tons, or 68 percent, were blended. The 91,700 tons represented 27 percent of all fertilizer materials (excluding rock phosphate) sold in Illinois that year. Thus, about 18 percent of the total fertilizer sold in the state in 1956 was blended.



Growth in the number of bulk-blending plants in Illinois since 1947. (Fig. 1)

Advantages

A bulk-blender can formulate any material that a soil test shows is needed. Low-cost straight materials are used, and no filler is needed to standardize mixture weight.

To a farmer, the main advantage of bulk-blended materials is their comparatively low cost. Production, transportation, storage, and spreading are all cheaper than for conventionally mixed fertilizers. Bulk-blended fertilizers usually cost about 15 percent less at the plant than conventional fertilizers containing the same amount of plant food (Table 1).

Investment in Land and Shelter

The capital investment required for a bulk-blending operation can vary a great deal. Of the three kinds of capital investment needed — land, building, and equipment — land usually takes the least outlay. An adequate site sells for about $1,500. Operators prefer a site with a railway siding, a high-voltage power line, a network of farm roads, and good fire protection.

Structures differ in appearance depending on space needed for blending equipment, number of storage bins, and the arrangement for unloading fertilizer materials from freight cars. Costs of course vary with the type and quality of materials as well as with the size of the building (Table 2). The range in cost is from $4,000 to $60,000.

B. J. Bond, formerly a graduate assistant in the Department of Agricultural Economics, is now on the staff of Washington State University. While here, he conducted this study as part of his graduate work, under the direction of E. R. Swanson and W. N. Thompson. Graduate students make many significant contributions to our research program.

Table 1. — A Comparison of 1957 Prices Paid by Farmers for Blended and Conventional Fertilizers Containing Equivalent Amounts of Plant Food[a]

Analysis	Conventional		Blended		Price difference
	Price	Total lb.	Price	Total lb.	
3-12-12	$50.00	2,000	$41.80	1,219	$ 8.20
4-16-16	65.00	2,000	54.80	1,625	10.20
5-20-20	78.00	2,000	67.80	2,032	10.20
10-10-10	66.00	2,000	53.95	1,732	12.05

[a] *Agricultural Prices,* September 15, 1957. Agricultural Marketing Service, U. S. Department of Agriculture.

Table 2. — Estimated Plant Structure Costs in Illinois, 1957[a]

Type of construction	Costs per square foot: Mixing room	Storage bins
Pole-supported, metal siding		
Low quality	$1.75	$2.75
High quality	2.75	3.75
Frame		
Low quality	2.00	2.00[b]
High quality	2.50	4.50
Concrete block	2.50	4.50

[a] Additional wiring costs would be $200 for plant entrance; $5 to $10 per light outlet; and $50 to $300 per motor outlet. [b] Plus 65 cents per square foot for non-partitioned bin walls.

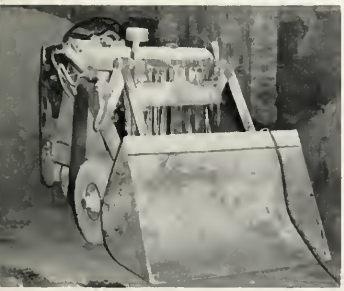
Investment in Equipment

Moving equipment. Most operators use bulk-loaders for moving fertilizer materials. Bulk-loaders are fast and maneuverable, and they handle loose materials efficiently in close quarters. They cost between $4,000 and $5,000.

Tractors with loaders are used to a lesser extent for moving materials, as are augers, elevators, and belt conveyors. In many plants belt conveyors are replacing both augers and elevators. They cost from $1,600 to $2,000 per 30-foot section.

Weighing equipment. Floor-level platform scales, costing $900 to $1,200, are used if materials are weighed before batching. Suspended hopper scales are used if materials are weighed during batching. One- to two-ton hopper scales cost $3,500 to $4,500.

Mixers. Drum-type mixers are used in most plants. They hold from ½ to 2½ tons of materials and mix each batch in 2 to 4 minutes. The price of such mixers ranges between $3,000 and $4,000. Converted feed mixers are used in a few plants. They hold about 1 ton and cost from $500 to $3,000.



Bulk-loaders are generally used for moving fertilizer materials. (Fig. 2)

Temporary storage. Holding bins are used as temporary storage for both raw materials and the blended product. Those with a 10- to 25-ton capacity cost from $500 to $700. Floor intake hoppers with a screw in the bottom are used for feeding fertilizer materials into elevators and cost from $300 to $600.

Types of Plants

Bulk-blending plants are divided into three types depending on the primary direction of material flow through the blending process. These are: (1) horizontal flow, (2) vertical flow, and (3) combination horizontal-vertical.

In the horizontal flow plant, the blending equipment is on the plant floor and the fertilizer materials move from one blending operation to another by horizontal movements. In the vertical flow plant, the blending equipment is elevated in a vertical or tower arrangement and fertilizer materials flow from one blending operation to another by gravity. The combined horizontal-vertical flow plant incorporates selected features from the other two.

Costs and outputs for the three types are shown in Table 3. It has been assumed, in preparing this table, that each plant uses the best methods and equipment available.

Table 3. — Costs and Capabilities of Horizontal Flow, Vertical Flow, and Combined Horizontal-Vertical Flow Plants in Illinois, 1957

Costs and volumes	Type of plant: Horizontal	Combination	Vertical
Investment costs			
Equipment	$11,498	$16,538	$33,100
Building	12,800	16,800	23,500
Land	1,250	1,500	1,750
Total	$25,548	$34,838	$58,350
Daily volumes			
One man	96 T.	112 T.	136 T.
Two men	108 T.	132 T.	184 T.
Annual fixed costs			
One man	$7,170	$8,504	$11,998
Two men	7,230	8,564	12,058
Variable costs per ton			
One man	$38.49	$38.35	$38.22
Two men	38.58	38.49	38.28
Break-even volumes			
One man	747 T.	873 T.	1,211 T.
Two men	761 T.	887 T.	1,229 T.

Vertical flow plants have the highest building and equipment investments. They also have the highest daily output. The relative increase in daily output from adding a second man is greatest in this type of plant because the greater investment permits more flexibility in using labor. The break-even volumes — those necessary to cover all costs — are highest for the vertical plant, mainly because of the higher initial investment cost.

Costs and outputs of the horizontal flow plants follow a pattern just opposite to those of vertical flow plants. Horizontal flow plants have the lowest investments, lowest daily outputs, and lowest break-even volumes of the three types of plants.

Combination horizontal-vertical flow plants fall between the other two types in costs and outputs.

Rural Development in Southern Illinois

HAROLD H. GORDON and STANLEY E. CEGLINSKI

The whole state of Illinois stands to benefit from the Rural Development program that is now being worked out in Alexander and Pulaski counties.

Actually, the name "Rural Development" does not indicate the real scope of this long-range program. For the program is aimed at developing all the resources of the area — industrial as well as agricultural — so that incomes and living conditions will be generally improved. Although the problems of low-income families are a primary concern, the program is designed to improve the opportunities of all people. The Extension Service is taking the lead in the program, and many other agencies and organizations are cooperating.

The work in Alexander and Pulaski counties got underway in 1957 as a pilot study. Information gained from this study will be used in developing other county programs.

Features of the Two Counties

Alexander and Pulaski counties lie at the southern tip of Illinois. Topography varies from flat, river bottom flood plains to steep, rocky hills. The pattern of soil types is complex. Textures of surface soils range from light sands to heavy, compact, plastic, nearly gumbo clays. Between these extremes is a variety of silts and loams.

Farming is diversified. Major cash crops are corn, soybeans, cotton, and wheat. Fruit crops include peaches, apples, strawberries, and brambles. The area also has many livestock farmers. A few farmers are producing broilers and graded eggs.

Present production in the two counties is far below potential levels. As a result, many families have low incomes.

Harold H. Gordon is Assistant State Leader of Farm Advisers; Stanley E. Ceglinski is Assistant Farm Adviser in Pulaski-Alexander counties.

How the Program Was Developed

The Pulaski-Alexander pilot program is guided by a committee composed of local people, including farmers, industrial workers and leaders, bankers, editors, churchmen, educators, and civic club leaders. Farm organizations, chambers of commerce, service clubs, school superintendents, and individual citizens are working to recognize and solve existing problems. State and national groups are supporting the work.

Early in 1957, the committee guiding the program designated priority communities or areas. These were areas where farms were small and little use was being made of existing services, up-to-date technological information, or approved practices. It was recognized that the four major needs in the priority areas were for (1) information about land capability, (2) better planning and management, (3) refinancing and enlarging the farm business, and (4) added off-farm income.

Next, the support of local leaders in each priority area was enlisted. They encouraged attendance at meetings where members of the Extension Service and the Soil Conservation Service explained the Rural Development programs to residents of each area. These meetings were followed by six classes on farm problems.

In addition, Extension and Soil Conservation personnel visited many farms to learn the needs, desires, and resources of farm families, and to help work out farm plans.

Accomplishments

Thus far, 65 farm families have defined their goals and plans with the help of the Extension and Soil Conservation Services. Farm planning has involved both basic land use and improvements in buildings, equipment, livestock, and management practices. As an aid in deciding on land use, the Soil Conservation Service has mapped about 70,000 acres according to their type and capability.

Nine cooperators have either made repairs on their homes or have constructed new farm buildings. These include three barns for beef cattle and hay storage, a pole-type poultry laying house, a loafing barn for dairy cattle, a machinery storage shed, and cold storage rooms for eggs.

The Farmers Home Administration has refinanced two farmers cooperating in the program. One farmer, for example, obtained capital to buy 40 acres of adjoining land that would make his farm an economical unit; to build a pole barn; to apply needed soil treatment; to improve his herd of beef cattle; and to concentrate his indebtedness into one obligation.

Both the Rural Development committee and other organizations and individuals in the area are greatly interested in industrial development. They are therefore very pleased that the Shawnee Wood Chip Corporation has established a plant at Tamms. Every day the plant uses 100 to 130 cords of wood that would otherwise be wasted. This new market for woodland products makes improvement cuttings of timber immediately profitable, and also provides employment.

Much Lies Ahead

Although accomplishments to date have been encouraging, much remains to be done. More small industries are needed, for example, as well as farm improvements.

Among the plans now underway is one to provide vocational training in occupations other than agriculture. A number of other ideas will be tried as well. As a result, we can expect to see more changes made — in industries, number of people employed, types of farm enterprises, number and size of farms, and the general level of living.

PROGRESS for BETTER LIVING

K. A. KENDALL

YOUR COLLEGE OF AGRICULTURE has been making extensive plans for the 1960 Illinois Farm and Home Festival. This festival, the third such event, will be held on the University of Illinois campus on March 31 and April 1 and 2.

Through the festival, the college staff and students will try to develop a closer relationship with you, the people of Illinois. We want to show you how our research, teaching, and extension programs are designed to help you to become more effective in your varied occupations and businesses in the broad field of agriculture. "Progress for Better Living" will be the festival theme.

Something to See

Many results from the research program of the college will be exhibited every day from morning until evening. Each exhibit will be designed to tell a complete story. We believe that the agricultural exhibits will have a broad appeal not only to farmers, but to those in other businesses as well. Equally interesting will be the numerous demonstrations and exhibits which will be presented especially for homemakers.

Something to Hear

Every day outstanding speakers from the college staff will be on hand to discuss topics of vital interest to farmers, homemakers, and businessmen.

Something Special

Among the special events will be a Town and Country Art Exhibit, a folk and square dance workshop, and a drama festival. Counties throughout the state will be represented in these events.

Saturday, April 2, will be a special day for high school students who are interested in a college education. These young people and their parents will receive information concerning the many and varied career opportunities awaiting college graduates who have specialized in agriculture or home economics. They will also get some idea as to what college training and life on a university campus are like.

For Your Convenience

Parking spaces will be adequate and conveniently located. There will also be special food service in addition to the regular cafeterias and restaurants in the Twin City area.

For Additional Information

If you would like to know more about the festival, ask your county farm or home adviser, or write to the College of Agriculture, Urbana, Illinois.

K. A. Kendall, Associate Professor of Dairy Science, is general chairman of the festival committee.

About 15,000 visitors attended last year's festival.

OTHER COMING EVENTS

(At Urbana unless otherwise indicated)

Jan. 26: Crop Performance Day

Jan. 27-28: Illinois Custom Spray Operators' Training School

Feb. 1-3: Rural Pastors' and Lay Leaders' Short Course

Feb. 2-3: Agricultural Industries Forum

Feb. 3-4: Illinois Nutrition Conference

Feb. 4: Annual Fertilizer Industry Conference

Feb. 4-5: Annual Meeting of Illinois Society of Professional Farm Managers

Feb. 8-Mar. 18: Winter Short Course in Agriculture (see page 19)

Feb. 8-11: Cattle Feeder Days (Dixon Springs Experiment Station, Robbs)

Mar. 3: Swine Day

RESEARCH IN BRIEF

A Quantitative Test for Sugars in Ice Cream

Ice cream always contains a mixture of at least two and as many as ten or more different sugars. Always present are lactose, which is also called milk sugar; and sucrose, which is derived either from sugar cane or sugar beets.

In recent years, it has become common practice to substitute corn sugar (dextrose) or corn syrup for a portion of the sucrose. The sucrose provides the most desirable form of sweet flavor, but corn syrups produce beneficial effects on the body and texture of ice cream, and many manufacturers want to take advantage of these effects. Still other types of sugars may be used, such as invert sugar, which is a mixture of dextrose and levulose, or even honey.

From an analytical point of view, ice cream which, for example, contains lactose, sucrose, and corn syrup presents a formidable problem. Corn syrup itself is a very complex mixture of some ten different sugars, many of which have very similar chemical properties. The first obstacle which must then be overcome is to separate the sugars in some way so that each component of the mixture can be analyzed individually.

A test has been developed in the Department of Food Technology which has made it possible to separate all the sugars in a simple operation. It also has the advantage that no treatment of the sample is necessary before analysis except dilution with water.

The separation is accomplished by paper chromatography. When a quantity of the melted ice cream is deposited on chromatographic paper and an organic solvent is allowed to flow through the paper, the sugars move away from the original point of application, each sugar moving with its own characteristic velocity. When the separation is complete, each sugar is washed off the paper separately and a quantitative determination is made using a photoelectric procedure — *T. C. Chou and J. Tobias*

Cereal Grains Tested in Swine Rations

Formulation of rations with maximum nutritional and economic value is a continuous phase of research in the Department of Animal Science.

In recent tests with pigs, barley, milo (grain sorghum), oats, and wheat were evaluated as replacements for corn in corn-soybean meal rations fortified with vitamins, minerals, and antibiotics. Pigs averaged about 45 pounds in weight to start with, and were fed until they weighed about 200 pounds.

For some of the tests, each cereal replaced the corn on a pound-for-pound basis. In other tests, the rations were formulated to contain equal amounts of protein. This placed more emphasis on the protein quality and quantity of the grains, since varying amounts of soybean meal had to be added to the different grains to provide a given protein level. The soybean meal content of the ration varied from 6 percent with wheat to 16 percent with corn. Consequently, the total protein in the ration varied considerably in quality (amino acid balance).

According to growth and feed-efficiency data thus far, the performance of the pigs was not improved by replacing the corn with any of the grains. When replacement was on a pound-for-pound basis, pigs on a milo or a wheat ration gained about 99 percent as fast as pigs fed a corn ration. The rates of gain on oats and barley rations were 88 and 54 percent, respectively, of the rate on corn. Feed utilization followed a similar pattern, except that barley was 93 percent as efficient as corn in providing a unit of gain.

When protein levels were equalized, milo, wheat, and oats rations produced gains that were 97, 85, and 82 percent of those on the corn rations. (Barley was omitted in this series of tests.) On the basis of feed efficiency, milo and wheat were 92 percent as efficient as corn; and oats were 81 percent as efficient.

The effect of pelleting upon ration utilization was also studied. All rations were fed in both meal and pellet forms. Pelleting markedly improved the feeding value of the barley ration, although the best performance on barley was still inferior to the poorest performance on the other cereals. These results suggest that the quality of barley used was very low.

Pelleting wheat and milo rations gave some increase in gain, but results with corn and oats rations were inconsistent. Feed efficiency was slightly improved by pelleting wheat and milo rations.

Carcass measurements are being evaluated to find out how cereal grain in the ration affects carcass quality. — *A. H. Jensen*

What Makes a Plant Resist Disease?

Many disease-resistant crop varieties have been developed; however, we know practically nothing about the cause or nature of resistance. Basic information on this subject could aid in the further development of resistant varieties, and suggest new and better methods of control. Conceivably, it could also help solve the problem of new races of pathogens that can attack resistant varieties.

The Phytophthora root and stem rot disease of soybeans is almost an ideal disease to use in studying the nature of resistance. Highly resistant and extremely susceptible soybean varieties are available. Resistance is controlled by a single dominant gene. Soybean plants can be easily inoculated, and susceptible plants are killed relatively quickly. Experiments thus do not take a long time.

When the fungus that causes root and stem rot is placed in a wound in a young soybean stem, it begins to grow in between the cells. If the plant is susceptible, the fungus makes abundant growth. The cell walls separate from each other and are killed. Soon the stem becomes brown and soft, and the seedling collapses. If the plant is resistant, the fungus starts to grow between the cells in exactly the same way. The cell walls begin to separate, but then something happens to the fungus. It develops cross walls (in this species cross walls indicate unfavorable growing conditions), stops growing, and then dies.

We know that a single gene is responsible for resistance. But what is its mode of action? Is it responsible for a toxic compound in resistant plants that kills the fungus? We have not been able to demonstrate a toxic material in healthy resistant soybeans. Possibly the resistant plant produces a toxin in response to the invading parasite. Another possibility could be that some essential nutrient is absent in the spaces between the cells where the fungus grows. These theories are being investigated in the Department of Plant Pathology.

An understanding of the nature of the resistance of soybeans to Phytophthora could have important applications in other disease problems. — *J. W. Gerdemann*

Why Do Cattle Refuse Certain Second-Cutting Legume Forages?

During the 1958-59 barn-feeding season, many livestock farmers in Illinois reported that their cattle or sheep slobbered, or salivated excessively, after one to three feedings of second-growth legume forages. Whether the forage was hay, silage, or pasture, the cattle refused to eat any more than about 15 pounds. The resulting decrease in milk production, plus the need for buying replacement forage, caused a severe economic loss.

The effect of molasses on the palatability of this forage was tried in the Department of Dairy Science. Cattle would consume the molasses-hay if they didn't have anything else to eat; but when they received grain and silage, they refused the molasses and hay.

Slobbering resulted from eating some second-growth legume forages.

Preliminary laboratory studies suggest that the excessive salivation may be associated with the mineral content of the forage. Chemical analyses show a disturbance in the ratio of sodium to potassium that has been reported as toxic for chicks and rats. It is interesting that, of the two areas in the state reporting the greatest incidence of the condition, the soil in one requires heavy applications of potash fertilizer, while the soil in the other has a high potash content.

Our studies also indicate that the causative agent (or agents) is heat-stable and hot-water soluble. Several animals have salivated excessively after being drenched with the ash obtained from the forage. And hot water extracts of the forage have caused slobbering in less than 45 minutes.

Some laboratory tests have been run on saliva from cows that have consumed the forage. Results indicate that the factor responsible for the slobbering reduces the amount of sodium bicarbonate in the saliva. This may deplete the alkaline reserve, and this may in turn reduce the efficiency of feed utilization in the rumen.

Further studies are underway to determine the causative agent responsible for the excessive salivation. — *J. H. Byers and H. P. Broquist*

Chemicals May Control Root and Stalk Rots

The control of soil-borne plant diseases with chemicals is the objective of a new research project in the Department of Plant Pathology. At present, there is no satisfactory and economical way to combat these diseases.

The most prevalent soil-borne diseases are root and stalk rots, which are caused by any one of several soil-inhabiting fungi. These organisms persist in the soil almost indefinitely and attack a wide variety of crop plants. Some of these fungi are damaging at the relatively low soil temperatures of 50° to 60° F., while others are more injurious at higher temperatures. Most if not all agronomic and horticultural crops, including field and sweet corn, green beans, peas, and onions, are affected by root and stalk rots.

In developing a soil-fungicide program, three things must be considered: (1) effectiveness of the chemical against pathogenic fungi, (2) method of application, and (3) effect on the seedlings. In preliminary tests in 1958, for example, a 20-percent Terraclor (pentachloronitrobenzene) dust gave promising control of white rot of onion without injuring the seedlings. That year the chemical was broadcast over the soil at 125 pounds per acre and mixed with the soil to a depth of 2 inches. In 1959, however, several formulations of Terraclor were applied in the furrow with the seed, and onion seedlings were severely injured, even when the rate of application was only 2 pounds per acre.

Several fungicides are being screened in the laboratory and greenhouse to determine their effectiveness against the fungi causing root and stalk rots. The best of these chemicals will be tested for their effect on seedling growth and the extent of their movement and breakdown in the soil. As a final step, practical and economical means for applying the most effective fungicides to the soil in the field will be sought. — *M. B. Linn.*

The Competitive Position of Soybeans

Soybeans are made into two products: (1) meal, a high-protein food and feedstuff; and (2) oil, which is of relatively high quality and is used for food and in industry.

Meal is in short supply and has a rapidly expanding market. Despite rapid increases in the size of the soybean crop, it has been very difficult to supply the market for soybean meal.

Oil, on the other hand, is in abundant supply and has a much more slowly expanding market. Demand for edible fats and oils in this country is extremely inelastic. Possibilities of expanding the domestic market, except at very low prices, are negligible. Nearly 40 percent of all the fats and oils produced in the United States this year will be shipped abroad under the P. L. 480 scheme of surplus disposal.

The limited domestic market for soybean oil, the expanding market for meal, and the fact that one product cannot be produced without the other make the export market for edible fats and oils of paramount importance to the further growth of the soybean industry.

The way to solve the dilemma of too little protein and too much fat is to switch from fat to protein. The major shift can be accomplished by changing the relative production of the various oilseeds. Many of the world's fats and oils are secondary products, such as lard and cottonseed oil. But more than half of the fats and oils are primary products, manufactured from oilseeds. Chief among these oilseeds are peanuts, sunflower seed, copra, and palm kernels.

These crops, which compete with soybeans, all yield a much higher percentage of oil and a lower percentage of meal than do soybeans. This puts soybeans in a strong competitive position. Lowering the price of oil in relation to the price of meal would affect competing seeds more than it would soybeans. At current prices, for example, reducing the price of oil by 20 percent while holding the price of meal constant would reduce the value of soybeans by 6.5 percent, peanuts by 15 percent, copra by 19 percent, and sunflower seed by 15 percent. Soybeans can stop further increases in production of competing oilseeds if prices are allowed to seek their own level.

This way out of the dilemma has implications for U. S. price and trade policy. The soybean must be free to exploit the great strength of its competitive position. It is not now free to do so. Our export dumping schemes — specifically P. L. 480 — result in an artificially high world price for fats and oils that encourages continued expansion in the production of competing oilseeds but at the same time retards the consumption of fats and oils in the poor areas of the world. — *T. A. Hieronymus*

Phosphorus Needs of Wheat Can Be Accurately Gauged

The requirements of wheat for soluble phosphate fertilizer have been correlated with the P-1 phosphorus soil test. As a result, it is now possible to test a soil for phosphorus and estimate the phosphate needs of wheat. This highly practical correlation was a byproduct of a more comprehensive study of the "nutrient mobility" concept of soil-plant relationships.

According to the nutrient mobility concept, we would predict that the requirement of wheat for soil phosphorus would depend on three groups of factors: (1) rate and planting pattern of the wheat, (2) the form of the phosphorus already in the soil or added as fertilizer, and (3) the distribution of phosphorus in the soil in relation to the planting pattern. This implies that soil type has no influence on phosphorus requirements, except as chemical properties might vary widely. It also implies that yield does not determine phosphorus requirement.

Experiments to test this prediction were conducted at four locations along a 200-mile line from Dixon Springs to Urbana. Soil types varied widely, but all plots were low in phosphorus by the P-1 soil test. Five rates of soluble phosphorus, varying from 20 to 320 pounds of P_2O_5, were broadcast and disked into the soil. Check plots at each location received no phosphorus.

Although yield levels varied, the same relative response was obtained on all fields for similar soil test values. As was predicted by the nutrient mobility concept, neither the efficiency of the absorbed phosphorus, as measured by the P-1 soil test, nor the efficiency of the applied phosphorus was affected by wide variations in chemical and physical properties of the soil. Also according to prediction, climatic variations along the 200-mile north-south line did not affect results. Similarly, in two seasons, one much more favorable for wheat than the other, the relative response and the fertilizer requirements remained constant, although absolute yields varied widely.

The efficiency of the soil phosphorus and of the newly applied soluble phosphate may be expressed by this equation: $\log (A - y) = \log A - 0.0184b - cx$. In this equation A is the 100 percent yield, y the percent yield sought, b the P-1 soil test value, c the efficiency constant for the method of applying the phosphorus, and x the pounds of phosphorus (in terms of P_2O_5 per acre) that are needed to obtain y.

The value of c is roughly 0.0088 for soluble phosphate broadcast and double disked: and 0.0178 for phosphorus drilled in with the wheat. This difference is highly important. It indicates that, on a soil having a 20 pound P-1 test, 320 pounds of P_2O_5 applied broadcast are needed to raise yield to the 90 percent level; but 75 pounds drilled would raise the yield to 98 percent. — *R. H. Bray*

Drainage Laws and Practices Are Being Studied

The requirements of modern transportation are creating new problems in the design and construction of highway systems. One problem of much concern to both highway offi-

cials and landowners is agricultural and highway drainage.

This problem is being studied in the Department of Agricultural Engineering, with the aid of a grant from the Illinois Division of Highways. Existing Illinois drainage laws that apply to highways are being compiled and analyzed. Also being analyzed are the policies and practices that the Division of Highways and other agencies are using to meet the requirements of these laws.

The ultimate purpose of the study is to find more effective ways to control the flow of waters for the protection of highways and of the surrounding land. — *Carroll J. W. Drablos*

Changing the Length of the Gestation Period in Dairy Cattle

According to recent studies in the Department of Dairy Science, it should be possible to shorten the gestation period in cattle by selection, for this characteristic has relatively high heritability. The main economic value of a shorter gestation period would be the shortened calving interval. Reducing the interval between generations might also be of some importance.

Data on 2,063 gestations were analyzed. For the five breeds of dairy cattle in the University herd, the average gestation periods are: Ayrshire, 277.7 days; Jersey, 279.5; Holstein-Friesian, 279.6; Guernsey, 284.7; and Brown Swiss, 291.5. Significant breed differences were found in all possible comparisons, except between Jerseys and Holstein-Friesians.

A comparison of heritability estimates obtained by two different methods demonstrated that the fetus contributes almost eight times as much genetic variance to gestation length as the dam. Thus, the length of the gestation period is primarily a characteristic of the fetus. It was also found, in general, that male calves were carried 1.5 days longer than females.

By substituting the heritability of the characteristic, 0.42, into the appropriate prediction equation, it was predicted that in one generation of selection the average length of the gestation period could be shortened by 3.2 days. This would result if the only animals allowed to reproduce would be the 50 percent of the females and the 5 percent of the males born after the shortest pregnancies.

Only experimentation can determine how much change is possible after three or four generations of selection. Experimentation is necessary, also, to determine if any harmful effects, such as increased calf mortality, would accompany a shorter gestation period. — *J. C. DeFries, R. W. Touchberry, and R. L. Hays*

Keep up-to-date in agriculture by attending

THE WINTER SHORT COURSE

WARREN K. WESSELS

THE NINTH ANNUAL WINTER short course in agriculture and home economics sponsored by the University of Illinois College of Agriculture will be held February 8 through March 18 at Urbana. The program is especially designed for farm men and women 18 years of age and older.

Total cost for the 6-week session, including tuition, fees, books, supplies, housing, and meals, will range from $190 to $230. Housing and meals will be available in the University residence halls for both men and women. Some private housing is also available, and meals may be eaten at the residence halls, Illini Union cafeteria, or restaurants near the campus.

The Illinois Bankers' Association encourages its member banks to award $100 scholarships to selected individuals living in areas served by the banks. You may consult your banker, farm adviser, or agriculture teacher for more information.

Ten $100 scholarships are also offered by the Illinois Foundation of the Future Farmers of America. Only active members of the F. F. A. are eligible. To apply, see your local vocational agriculture instructor.

A Variety of Subjects

Students are encouraged to enrol in five or six courses that particularly interest them. They have their choice of the following:

Agricultural Marketing and Prices
Farm Management
Rural Group Leadership and Community Organization
Agricultural Law
Gas Engines and Tractors
Farm Electrification
Farm Buildings
Surveying and Drainage
Farm Welding
Farm Machinery
Farm Arithmetic
Grain Crops, Forage Crops, and Crop Hazards
Soil Management
Beef Cattle Feeding and Management
Swine Feeding and Management
Sheep Feeding and Management
Feeding, Management, and Selection of Dairy Cattle
Preventing and Controlling Diseases of Livestock
Dating, Engagement, and Marriage (for men students)

Other Opportunities

Short course students have all the privileges of regular University students. A number of recreational activities, including basketball, bowling, and swimming, are available.

Living, working, and playing with other short course students is a very worth-while experience. Informal contacts with other students, as well as with faculty members, may be among the most valuable benefits of attending the winter short course.

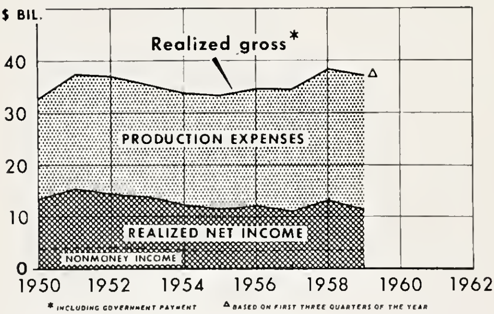
For more information and application blank, write to the Short Course Supervisor, 104 Mumford Hall, University of Illinois, Urbana.

FARM BUSINESS TRENDS

HUGE WAVES of inflation have brought drastic changes to farmers during the past 20 years. Farm income always increases rapidly during periods of strong inflation. Then, as rising wages bring increases in marketing costs and farm operating expenses, farmers' net income is reduced.

Following this pattern, net farm income increased from $4.6 billion in 1940 to $17.8 billion in 1948, then dropped back to $12.9 billion in 1949. It might have declined further at that time, but the Korean War brought more inflation, and farm operators' net income increased to $16.3 billion in 1951. By 1954 the net income of farm operators was down to $12.7 billion.

During the past six years net income realized by United States farm operators has fluctuated around the $12.0 billion mark. Best of the six years was 1958, when income was $13.1 billion. Lowest year was 1957, at $11.0 billion. Last year, 1959, was second lowest, with a realized net income of about $11.2 billion. For the three years 1954-1956, realized net income of farm operators averaged $11.9 billion a year; and for the three years 1957-1959, about $11.8 billion.



Realized net income declines in 1959

Gross farm income trended upward over the same six-year period, averaging $33.9 billion in 1954-1956, and $36.5 billion in 1957-1959. Production expenses, however, increased just as fast. They averaged $22.0 billion a year during the first three years and $24.8 billion during the last three years.

While total net farm income shows no strong up or down trend during the past six years, the trend of net income per farm has been upward. This is because the number of farms has been reduced as many farmers have taken over what formerly was two or more farms. The trend is quite apparent in most Illinois counties.

Various trends are also noticeable in the net income from specific types of farms, despite the lack of an over-all trend during the six years. Income from cash-grain farms in the corn belt has gone up one year and down the next, but has trended downward. The income from hog-cattle feeding farms showed a general upward trend. It hit a low in 1955, rose sharply in 1958, and turned down in 1959. Income from hog-beef cow farms was low from 1954 through 1956, rose to a new all-time high by 1958, and turned down in 1959. In most areas income from dairy farms followed a slight upward trend.

The amount of income that United States farmers obtain from nonfarm sources has increased by about 50 percent in the past 10 years. In 1959 such income totaled $6.5 billion, or two-fifths as much as was obtained from farming. Either wife or husband, or both, may work off the farm. About one-fourth of all farm wives (as compared with one-third of urban wives) were gainfully employed last year. — *L. H. Simerl, Professor of Agricultural Economics*

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To:

Spring, 1960

ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

IN THIS ISSUE

The porthole in this cow gives access to the rumen. Here some of the rumen contents are being removed for analysis (page 10).

Volume 2, Number 2 UNIVERSITY OF ILLINOIS COLLEGE OF AGRICULTURE URBANA, ILLINOIS

ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

CONTENTS

Spring, 1960 Volume 2, Number 2

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Louis B. Howard .... Dean and Director
Tom S. Hamilton .... Associate Director
Adrian Janes .... Station Editor
Margery E. Suhre .. Editor, ILLINOIS RESEARCH

RESEARCH IN THE DEPARTMENT OF AGRICULTURAL ENGINEERING

has as its broad goal the exploration of engineering principles and techniques that will help solve agricultural problems. Specific projects include those in farm power and machinery, farm buildings and rural housing, farm electrification and processing, and soil and water mechanics. Some studies, such as the one dealing with the mechanization of small fruit and vegetable production, have immediate and obvious significance. Others are more concerned with the delineation of applicable theory. Such a study is the one on the injection of anhydrous ammonia into soil through high pressure jets.

Research in agricultural engineering, like that in other areas, calls for the control of variables, and in agriculture the engineer is faced with some of the most difficult. Among these are soils, weather, water behavior, and genetic, biological, and physical differences in animals and plants. The agricultural engineer must have the ability and, more important, the sincere desire to work with other people — farmers, technicians, and professional people from other disciplines serving agriculture. His contributions are greatest when he serves as an effective team member.

Challenges abound in agricultural industry for well-trained engineers. More than a hundred students in the Department of Agricultural Engineering are now preparing themselves to help provide the expanded engineering service which will be demanded by the agricultural industry of tomorrow. — *Frank B. Lanham, Head of the Department*

A native West Virginian, Dr. Lanham attended the Virginia Polytechnic Institute and Iowa State University. His professional experience includes assignments in industry, the armed services, and university teaching and research. He also served for a number of years as executive secretary of the American Society of Agricultural Engineers before assuming his present position in 1955.

Better Pest Control With ANTIBIOTICS?

DAVID GOTTLIEB, Professor of Plant Pathology, has done much work on antibiotics, and in 1959 was invited to discuss the subject in Czechoslovakia and Poland. He has been at the University of Illinois since 1946.

This possibility is suggested by the ability of vancomycin to penetrate and move through plants

EVERY PROGRESSIVE FARMER uses fungicides and bactericides to protect his crops against the ravages of parasites. Most of these modern organic pesticides are very effective in doing the job for which they have been designed. Yet they do have certain limitations. They are sprayed or dusted on the outside of the plant and protect only the leaf or portion of the stem to which they are applied. They can be washed off by rain and the plant must be retreated. Furthermore, as plants keep on growing we must periodically spray or dust them to cover the new leaves and stem.

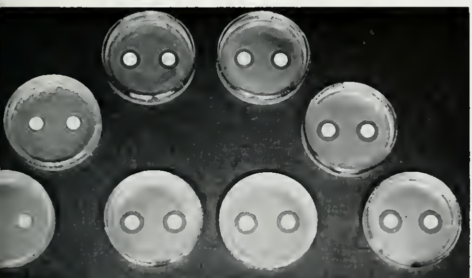
These difficulties would vanish if we could use some chemical that would move throughout the whole plant after being applied to the external surfaces of the plant or seed or even being injected into the stem. Such a material would not be washed off by rain and would be present in the new tissues to kill any pathogen that might penetrate the host plant.

An even more important goal would be to find a material which would move from the above-ground parts of the plant to the roots, protecting them from infection and decay. None of our present fungicides or bactericides will do this.

Three members of the Department of Plant Pathology have been studying the properties of antibiotics, in the hope of finding one that will move down into the roots when sprayed on the upper parts of the plants. Of those we have studied thus far, vancomycin seems most promising.

Why Vancomycin Was Studied

Although we were primarily interested in the movement of antibiotics in plants, we also wanted a material which inhibited some plant pathogens. Vancomycin had this characteristic, for it could prevent the growth of some bacteria in culture, including those that cause halo blight of beans, black rot of cabbage, and fire blight of pears.



Known amounts of antibiotic have been added to paper discs in the six Petri plates forming a semicircle. The antibiotic has moved outward, forming dark-looking inhibition zones around discs. These zones are standards for determining amounts of antibiotic in plants. The two lower center plates contain juices of plants treated with vancomycin. (Fig. 1)

Early studies showed that this antibiotic had other favorable properties: It was very stable to heat and was not easily absorbed by colloids. It would thus remain active in the plant if indeed it was absorbed by the plant in the first place. Furthermore, bacteria do not readily become resistant to this drug.

Vancomycin Penetrates Leaves and Roots

The first obstacle which vancomycin would have to hurdle before entering a leaf would be the surface membrane or the epidermis. To find if the material has this ability, we sprayed it on leaves of young tomato, bean, tobacco, and cucumber plants.

After various periods of time, the leaves were removed from the plant, washed thoroughly, and dried; and the internal fluid was squeezed from them. These juices were then assayed for the presence of the antibiotic.

We found active material in the fluids, indicating that the antibiotic could pass through the protective layer on the leaf surface. Intake was very rapid and could be detected in as little as 3 hours after spraying. As the concentration of the spray was increased, greater concentrations of antibiotic were found inside the leaves.

The antibiotic did not remain in the leaves indefinitely but became inactivated after a number of days. Yet, with sprays of a concentration of 500 p.p.m., enough vancomycin remained even after 20 days to in-

hibit bacteria growing in culture media. The rate of absorption was higher at night than in the day.

Roots were even more active than the leaves in absorbing the antibiotic. When roots were put into concentrations of 25 p.p.m., they accumulated 4 p.p.m. within 3 hours.

Movement Through Plant

Vancomycin met another of our criteria for an efficient antibacterial agent. It was able to move both upward and downward in the plant. This was demonstrated by spraying the middle leaf of a tomato plant with a 1-percent solution of the antibiotic and analyzing portions of the plant at various distances above and below the sprayed leaf. Vancomycin was found in all parts. Distribution was not even, for more material was found in the leaves than in the stem through which the antibiotic had to move.

A very interesting and important observation was made at the same time: Vancomycin moved down the plant more readily than up the plant. Leaves below the sprayed one contained much more antibiotic than those above it. No other antibacterial agent has been shown to be translocated in this way. The downward movement continued into the roots, where the antibiotic could be detected in inhibitory concentrations even after 48 hours. Here, perhaps for the first time, was a material that might protect the roots of a plant from infection when sprayed on the crown.

Vancomycin also moved from the roots up into the stem and leaves. This type of movement was very efficient in all plants studied. Immersing roots of lima beans in solutions containing 10 p.p.m. of vancomycin gave root concentrations of 60 p.p.m. and leaf concentrations of 9 p.p.m. for at least 10 days. At higher treatment levels greater amounts were accumulated, until at the 500 p.p.m. dose, the root contained 1,000 p.p.m., the stem 22, and the leaves 75 p.p.m. after 24 hours. The remarkable feature is that the concentrations in the root were higher than in the external fluid.

Soil Treatment Possible

The efficient intake of antibiotic by the roots opened the possibility that the antibiotic might be used to treat soil. It could then be absorbed by the plant and translocated through all tissues. To test this possibility, tomatoes growing in potted soil were watered with antibiotic solutions for various periods of time and then analyzed. Vancomycin did indeed appear in the roots and upper parts of the plant, indicating that soil treatment might be feasible.

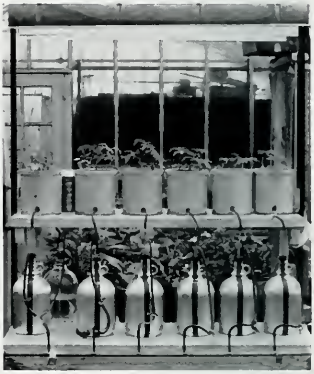
There is one drawback to treating the soil with antibiotic: Much of the antibiotic is inactivated in the soil before it can be absorbed by the roots. Part of the inactivation is due to soil microorganisms whose enzymes degrade the antibiotic. In addition, the clays in soil adsorb some of the antibiotic, binding it so tightly that it is unavailable to the plant. Nevertheless, the absorption by roots is so efficient that considerable amounts of the antibiotic do get into the plant.

Seed Treatment

Another way in which plants can be protected from disease is by treating seed with a fungicide or bactericide. When soaked in solutions of vancomycin, seeds absorbed the antibiotic. With the growth of the young seedlings, the material was carried into both the root and crown parts in concentrations that should inhibit some pathogenic bacteria. Again the amount that was concentrated in the young seedling was correlated with the concentration originally used in the seed soak.

One Loophole Remaining

During all these experiments, we assumed that vancomycin was the antibiotic that we found in the sap of the plant after our treatments. We felt especially safe in this assumption because we treated control plants in exactly the same way as experimental plants except that no vancomycin was added to the spray; and we found no antibiotic in the control plants.



Tomato plants growing in sand culture. Nutrient solutions containing vancomycin are forced from the jugs up into the crocks four times a day. Roots absorb the solution and the antibiotic moves through the plant. (Fig. 2)

Still, however, a doubt might remain as to whether the antibiotic recovered from the plant was actually vancomycin. Final proof was obtained when we showed by a chemical technique of paper-chromatography that the antibiotic recovered from the plant was the same one that we had added.

Encouraging Results

Current evidence thus indicates that vancomycin has the unusual property of penetrating the epidermis of leaves and moving both up and down the plant. It can also be absorbed and concentrated in the roots and translocated to the crown of the plant. When absorbed by the seed, it moves along the growing tissues of the seedlings.

These properties, plus vancomycin's antibacterial action, give promise that this material can be used in the control of some bacterial diseases. But perhaps a far more important result of our work is the encouragement it has given us to continue research with antibiotics in general as potential agents for the control of plant diseases.

How pH and day length affect ROOTING of EVERGREENS

J. R. KAMP

HOW DAY LENGTH affects the rooting of cuttings has been found in recent tests to vary with the pH of the rooting medium.

In previous experiments, evergreen cuttings had rooted better under an 8-hour day than under a 16-hour day. The rooting medium had been builders sand which contained some lime. Moisture had been supplied by intermittent mist that was just slightly alkaline.

But what would have happened if the rooting medium had been acid? To learn how pH would affect the rooting of evergreen cuttings, a series of tests was run with Hatfield yew.

Experimental Setup

The first tests were started on November 20, 1958. Beginning March 3, 1959, the tests were repeated. Both times 100 days were allowed for rooting.

Day lengths of 8 and 16 hours and pH values of 5, 6, 7, and 8 were tried. Three replications were made for each photoperiod (day length), and 21 cuttings were made per replicate.

Cuttings were graded as follows by photographic standards: Excellent (E), Good (G), Fair (F), Poor (P), Callused (C), and No callus (N). Numerical values were assigned to the various grades for statistical analyses: E — 5 points, G — 4, F — 3, P — 2, C — 1, and N — 0.

Results

Rooting followed the same pattern in both the November and the March tests. Results of the November tests are given in the table.

In no case was rooting satisfactory at pH 5. Most of the cuttings became discolored at the base, and many later decayed. Very little of the callus tissue from which roots develop was formed. The few cuttings that did make roots produced only a few poor ones. Results were the same for both day lengths.

At pH 6, the cuttings made heavy callus. Although very few had produced roots by the end of 100 days, the cuttings were still in good condition and would probably have rooted well if left longer in the rooting medium. Again day length did not affect the results.

By far the best rooting was at pH 7. This was true under both day lengths. However, cuttings rooted very much better under 8 hours of light than under 16 hours.

At pH 8 also, rooting was significantly better under the short than under the long photoperiod. While rooting at pH 8 was not as good as at pH 7, it was significantly better than at pH 5, regardless of day length. Also, under an 8-hour day, rooting at pH 8 was better than rooting at pH 6, although this was not true under a 16-hour day.

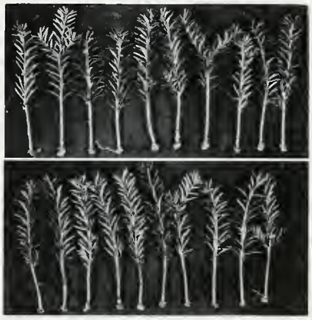
Other Plants Probably Similar

Because other research at the University has indicated that other plants have rooting patterns similar to that of the Hatfield yew, it seems likely that they may be similarly influenced by an interaction between pH and photoperiod.

For the present, at least for evergreens, we suggest rooting in a neutral or slightly alkaline rooting medium under short-day conditions.

J. R. Kamp, Associate Professor of Floriculture, has done much research on the propagation of woody ornamentals.

Cuttings rooted at pH 7 did much better under short-day conditions (bottom row) than under long-day conditions (top).



At pH 6, photoperiod made no difference in rooting of cuttings. (Cuttings rooted under long-day conditions are in top row; short-day conditions, bottom row.)

Grades and Scores of Cuttings Under Long- and Short-Day Conditions (Summation of three replicates)

pH of medium	E	G	F	P	C	N	Score[a]
			LONG DAY (16 hours)				
5	0	0	1	13	2	47	31
6	0	0	0	13	50	0	76
7	0	5	12	18	28	0	120
8	0	0	1	15	47	0	80
			SHORT DAY (8 hours)				
5	0	0	0	14	22	27	50
6	0	0	1	10	52	0	75
7	8	14	21	14	6	0	193
8	1	4	10	27	21	0	126

[a] Scores were obtained by multiplying the number of cuttings in each grade by the numerical value assigned to that grade.

DEGREE DAYS . . .

An Accurate Way of Predicting Crop Development

C. Y. ARNOLD, Associate Professor of Vegetable Crops, has been at Illinois since 1942. Until 1947 he was at the Cook County Experiment Station. He is primarily interested in the relationships of soil and climate to vegetable crops.

THE WEATHER FORECASTER in recent years has made us familiar with "degree days" as a means of comparing the severity of one winter with that of another. Degree days are proving to be a valuable tool of the horticulturist, also, in predicting the time when a crop will reach a certain stage of development.

Most seed catalogs make the prediction of crop development sound deceptively easy by stating the number of days in which each variety may be expected to reach the harvest stage. The Alaska variety of peas, for example, is listed as a 59-day variety. However, it may actually be ready to harvest at any time from 45 to 80 days after planting. This variation is caused by variations in the environmental factors that affect the rate of plant development. By far the most important of these factors is temperature.

The value of degree days is that they minimize the errors caused by temperature variations. A degree day, calculated from average daily temperatures, is what is known as a heat unit. Although the present discussion is confined to the degree day, another kind of heat unit may also be used in predicting crop development. This is the degree hour, based on hourly temperatures.

How Heat Units Are Calculated and Applied

In calculating heat units for horticultural purposes, we are concerned only with the temperatures that affect plants. Peas, for example, do not begin to develop until the temperature reaches about 40°. This is called the base temperature.

A degree-day total is calculated as the average temperature minus the base temperature times the number of days. Thus, if the average temperature for one day was 50°, the degree-day total would be $50 - 40 \times 1$, or 10 degree days. If the average temperature for two days was 45°, the degree-day total would be 10 again $(45 - 40 \times 2)$. It is thus assumed that when the temperature averages 45°, a crop will take two days to develop as much as in one day of 50° average temperature.

The number of degree days required for a particular variety to reach the harvest stage is determined by experimental observation. The Alaska pea variety, for example, is no longer a 59-day variety, but rather a 1220-degree-day variety.

As an example of the application of the degree-day system to a practical problem, let us follow its use by a canner who has planted Alaska peas in northern Illinois on April 15.

From a degree-day accumulation chart based on normal temperatures in the area, he determines that 1220 degree days are normally accumulated between April 15 and June 20. Thus June 20 is the first predicted harvest date. By following the current season's degree-day accumulation, he can detect departures from normal, and revise the predicted harvest date at any time.

Alaska peas reach the 50-percent bloom stage in about 800 degree days. When the degree-day accumulation approaches this value, the field is checked until the 50-percent bloom stage is reached. This permits the elimination of errors which have resulted from the effects of drouth, insects, and disease on crop development. A revised prediction of the harvest date is made on the basis of the remaining 420-degree-day requirement. When the degree-day accumulation indicates that harvest is a few days away, a sample of peas is tested for tenderness. On the basis of the results, or subsequent tests of the same kind, the harvest date is decided.

Research on Heat Units

The Department of Horticulture has been doing research on heat units since 1954. The program was developed into an extensive examination of principles and methods used in the system. Two highlights of the results are reported here.

Maximum-Minimum Temperatures

When degree days are calculated from the average of daily maximum and minimum temperatures, the formula used is as follows: Maximum plus minimum divided by two minus the base temperature times one day. Thus, if the maximum is 58° and the minimum is 42°, the degree day total for peas would be $\frac{58 + 42}{2} - 40 \times 1$, or 10.

This formula gives a reasonably accurate measurement of degree days when the minimum temperature is above the base temperature. When the minimum falls below the base temperature, however, the formula is no longer accurate.

The nature of the problem involved is illustrated in Figures 1 and 2. Graphically the measurement of degree days is a measure of an area such as the shaded areas in these two graphs. This can be easily seen if in your mind's eye you will tip the area X in Figure 1 upside down and place it in the area Y. You now have a rectangle which is 10° high and 1 day long; the area of the rectangle thus represents 10 degree days. Now, if you try the same

thing with area X in Figure 2 you will find that the entire area disappears below the base line and that the area above the line is zero. What is needed in this case is a measure of the area X itself.

In searching for an answer to this problem we looked for a mathematical curve which resembled the normal daily temperature curve. The sine curve was selected. The close resemblance of this curve to the daily temperature curve is indicated by the fact that the curves in Figures 1 and 2 are sine curves.

From Dr. C. E. Mendel of the Department of Mathematics, we obtained a formula for measuring the area under a sine curve and above the base temperature when the maximum and minimum are known. Using this formula we have made up a table which gives this area as degree days from any maximum and minimum temperature. This table may be obtained from the Department of Horticulture.

Correct Base Temperature Essential

Determining the correct base temperature is of prime importance if the formula for measuring degree days is to give accurate results.

What happens if an incorrect base temperature is used is shown in the table. We have assumed that a hypothetical variety X takes 90 days to reach the harvest date if the average daily temperature is 60°, and 60 days if the temperature is 70°. When the correct base temperature

How Incorrect Base Temperature Affects Calculation of Degree-Day Accumulation

Aver. temp.	Days to harvest	Degree-day accumulation: Correct base temp. 40°	Degree-day accumulation: Incorrect base temp. 50°
60°	90	1800	900
70°	60	1800	1200

of 40° is used to calculate the degree-day requirement, the result is the same at both average temperatures.

When a 50° base temperature is used, however, the degree-day requirement is higher at 70° than at 60°. This is because we are underestimating the daily degree days by 10. At an average temperature of 60°, this error is repeated once every day for 90 days. The degree-day total for the variety is thus reduced by 900. But at a 70° average temperature the error occurs only 60 times and the total is reduced by 600 degree days.

This effect can be generalized by saying that when the selected base temperature is too high the degree-day requirement for a variety will increase with the mean temperature during the growing period. If the selected base is too low, the reverse trend will take place.

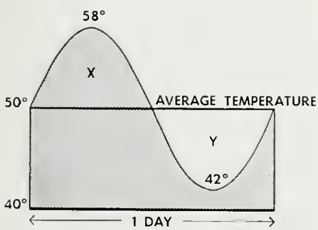
Because of the importance of determining the base temperature accurately, some of our research has been directed at developing a new method.

In this method, base temperature is determined by information gathered from a series of plantings. For each planting, the average temperature between planting time and harvest and the percent of development per day are determined. Results are plotted on a graph. Each dot in Figure 3, for example, shows average temperature and rate of development for one planting.

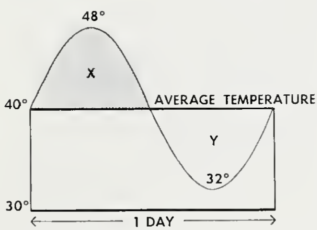
A statistical method is then used to determine the line best describing the relationship between dots. This line is extended below the range of dots to the point where the rate of development is zero. The temperature at this point is the correct base temperature.

Many Jobs Easier

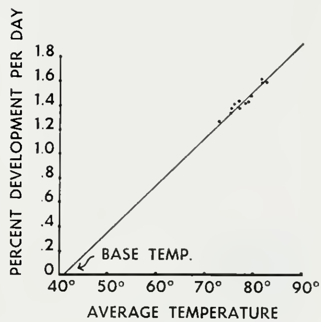
With the development of more accurate methods of predicting crop development, a number of jobs have become simpler. It is, for example, easier to evaluate length of season in potential production areas. Successive plantings can be timed to reduce gaps and gluts in the harvest; and can production and canning operations can be timed to fit the harvest schedule. Promotional programs can be timed to move produce at a high price during the peak of harvest. And fewer field inspections are needed to catch crops at the peak of quality.



The shaded area under the temperature curve gives us the degree day total. When the minimum temperature is above the base (40° in this example), area X fits into area Y, forming a rectangle that measures 10 degree days. (Fig. 1)



Here the base temperature is again 40°, but the minimum temperature falls below the base. Thus degree days cannot be measured by fitting area X into area Y, and another method of measurement must be found. (Fig. 2)



Percent of development per day plotted against average temperature between planting and harvest, for 12 plantings of Golden Cross Bantam sweet corn. The correct base temperature (41°) was determined from these data. (Fig. 3)

Steps to prevent epidemics of
INSECTS in Pine Plantations

R. G. RENNELS

So far in Illinois we have had but few serious outbreaks of insects in pine plantations.

This good fortune, however, should not encourage an attitude of complacency, for the picture can change very rapidly. More and more pines are being planted, the distances between plantations are being reduced, and some extremely destructive insects have been found on landscape pines throughout the state.

The situation thus calls for continual vigilance if epidemics are to be averted. We can hope to avoid serious losses only by obtaining vital information on potentially destructive insects, preferably before outbreaks occur.

To obtain this information, the Department of Forestry is making a complete inventory of destructive and useful insects affecting Illinois pine plantations. In addition, specific insects such as the Zimmerman pine moth, evergreen bagworm, and European pine shoot moth are being studied to ascertain any peculiarities in their natural histories that may be of value in developing controls.

Objectives of Forest Insect Control

Knowing the viewpoint of foresters and forest entomologists toward insect control will help in understanding the work being done. First, they consider forest insects as part of the forest community. Control simply means reducing the number of insects to a level where either no damage occurs or, more likely, where there is an acceptably low economic loss.

With this in mind, plantation management procedures are designed whenever possible to produce conditions generally unfavorable for the development of large insect populations. This approach to forest insect control is an attempt to attain or retain the natural balance of organisms in the forest at the lowest possible cost. When control cannot be achieved in this way, either because we don't know enough about an insect's requirements or because we don't have enough time to attain the balance, we must either accept the losses or use another means of control.

R. G. Rennels is Assistant Professor of Forestry, doing both teaching and research. He is primarily interested in studying the relationship of forest insects to their environment so that economical control measures can be developed.

Zimmerman Pine Moth

The study of the Zimmerman pine moth has been going on for eight years. We have found that the larvae may attack the buds, branch tips, and trunks of most if not all pines. Attacks on buds and branch tips stunt the trees and also cause poorly developed crowns. Poorly formed or forked stems often result from trunk infestations (Fig. 1). Infestations of buds and shoots often distort the trees so much that they are unmerchantable for use as Christmas trees or ornamentals.

Planting the least susceptible species (see table) is one way of keeping damage acceptably low in plantations. It is hoped that strains less subject to attack or injury will ultimately be found.

Fork in this Scotch pine resulted from a heavy trunk infestation by the Zimmerman pine moth. (Fig. 1)

Maintaining a dense stand of trees will also help to keep down damage. This will become easier as we learn more about the ability of various soils to produce vigorous tree growth.

Chemical control may be possible and economically feasible when the insect attacks ornamental pines or Christmas tree plantations. Experiments have indicated that DDT will give good control when applied at critical periods in the life cycle of this moth.

Infestation of Zimmerman Pine Moth in Experimental Plantations of Different Pine Species at Sinnissippi Forest, 1951

Host species	Number of trees per acre	Number showing active infestation	Number free of active infestation	Percent infested
Scotch pine (*Pinus sylvestris* L.)	655	513	142	78
Corsican pine (*Pinus nigra poiretiana* Ant.)	713	614	99	86
Japanese red pine (*Pinus densiflora* Sieb.)	418	263	155	63
Red pine (*Pinus resinosa* Ait.)	1,073	444	629	41
Western yellow pine (*Pinus ponderosa* Dougl.)	600	165	435	27
Lodgepole pine (*Pinus contorta* Dougl.)	416	76	340	18
Jack pine (*Pinus banksiana* Lamb.)	1,035	61	974	6

A detailed report of our research on the Zimmerman pine moth will soon be published in an Experiment Station bulletin.

Evergreen Bagworms

Almost everyone is familiar with bagworms, an important enemy of ornamental evergreens. These insects are rather general feeders and are usually the culprits when eastern red cedar and other junipers lose their foliage.

Within the last few years, they have been found with increasing frequency feeding on pines. This has caused some alarm in the Christmas tree industry. Growers have feared that bagworms might be transported on infested Christmas trees into uninfested areas, where they might damage pines extensively.

According to investigations at the Illinois Station in 1958 and 1959, it is true that bagworms can be spread when trees which have been indoors during the Christmas season are moved outdoors, and that bagworms can at least partially defoliate pines in the field. They are not, however, believed to be a serious threat to pines for several reasons.

First, bagworms are already present in most, if not all, areas of the state where they are able to survive. Second, introduction of a few bags containing eggs on Christmas trees would have very little impact on the local bagworm population. Third, parasites appear to be increasing in numbers and reducing bagworm populations in pine plantations before serious damage is done. Finally, pines are not the preferred host of bagworms. This will further deter the build-up of large populations in pine plantations.

Plantation owners should nevertheless look for bagworm concentrations if eastern red cedars are in the same plantation with pines or if ornamental junipers or eastern red cedars are nearby. Only rarely does it appear that chemical control measures against bagworms should become necessary in pine plantations.

European Pine Shoot Moth

Unquestionably, the European pine shoot moth is one of the most serious threats, if not the most serious, to Illinois pine plantations. Scotch and red pines are especially susceptible. So far this pest has shown up in these seven counties in the central, east-central, and northeastern parts of the state: Logan, McLean, Champaign, Iroquois, Cook, Lake, and McHenry.

The moth attacks buds and developing shoots. Heavy infestation may completely arrest growth in height. Repeated and prolonged attacks may kill the trees.

No completely adequate control has yet been found for this moth once it has invaded a plantation. According to research results thus far, however, DDT appears to give reasonably good control when sprayed on infested ornamental pines in mid-April and early June.

Future Research

We hope that ultimately our research will enable us not only to predict outbreaks of destructive species but also to recommend measures that will prevent outbreaks. Studies of the insects discussed above are to be continued by the Illinois Station, and from time to time other destructive species will be studied.

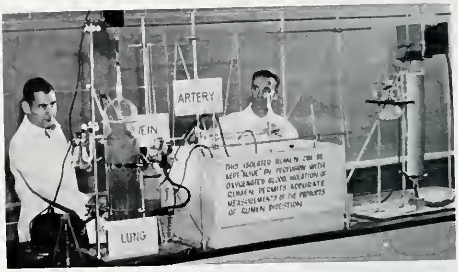
Various systems of surveying and reporting insect populations are now under study. The organization and adoption of an ideal system would eventually make possible periodic reports on at least our most serious forest insects.

The need for reports of this nature will become greater as the acreage of our forest plantations and the accompanying forest insect problems increase. The cooperation of ornamental-tree owners, nurserymen, farmers, foresters, and entomologists will also become increasingly valuable.

Owners of pine plantations in particular are encouraged not only to check their plantings carefully during the spring and summer but also to write the Department of Forestry of the University of Illinois regarding the occurrence of destructive forest insects. We will help in any way possible. Moreover, the information that you supply may be of value to others.

Red pine buds showing resin accumulation caused by the feeding of European pine shoot moth larvae. (Fig. 2)

The Fuel Value of FEEDS for RUMINANTS



R. E. Brown and C. L. Davis demonstrate the apparatus that they have developed to keep a rumen functioning after it has been removed from an animal. Both Dr. Brown and Dr. Davis are Assistant Professors of Nutrition in the Department of Dairy Science.

R. E. BROWN and C. L. DAVIS

JUST as an engine requires fuel to perform work, animals need an energy source to keep their tissues and organs functioning.

The combustible nutrients in feeds can be thought of as animal fuels. They are as important to an animal as gasoline is to an automobile engine. If dairy cattle don't get enough energy-yielding nutrients in their rations, for example, their milk production immediately goes down. Cows, like most animals, have a rather small fuel tank and cannot store a very large supply of readily available energy.

Rumen Makes Nutrients Available to Tissues

Digestive processes in the gut turn feed nutrients into compounds that the animal can utilize. In cattle and sheep much of the digestive action occurs in the rumen. There microbes cause feeds to ferment, producing a variety of combustible organic acids. These are absorbed into the blood and become available to the tissues, where they are oxidized to produce energy.

The amount of energy available to the tissues of cattle and sheep thus depends largely on the total quantity of organic acids produced in the rumen. The relative amount of each acid is also important because, like engines, animal tissues use some fuels more efficiently than others.

Studies are therefore being conducted in the Department of Dairy Science to find the answers to two questions: (1) How much of the various energy-yielding compounds are made available to ruminant tissues by absorption from the rumen? (2) How efficiently are they utilized?

A Complex Problem

Measuring the amounts of the various organic acids that are absorbed from the rumen into the blood is a complex problem.

Of the acids produced in the rumen, the most important are acetic, propionic, and butyric. Samples taken from the rumen contain relatively large concentrations of these acids. Moreover, the concentrations vary at different times after feeding, confirming that the acids are indeed produced from feedstuffs in the rumen.

The changes in concentrations, however, will not tell us how fast the various acids are being produced. For these changes don't depend on production rates alone. They depend also on the rates at which the acids are absorbed into the blood, are diluted with water or saliva, or pass to the lower parts of the gut.

Amounts of Available Acids Can Be Determined

To study the rates at which organic acids are produced and absorbed in ruminants, we have developed a way of removing the rumen and keeping it functioning outside the animal. This way, we eliminate the complications caused by the dilution of the rumen contents with water or saliva, and by the passage of rumen contents into the lower gut.

One hour after receiving a test diet, the animal is anaesthetized and bled-out. The rumen is quickly removed and tied off at both the inlet and outlet so that none of the contents can get out except by absorption into the circulating blood. Tubes are placed in the rumen artery and vein, and blood is perfused or forced through the blood vessels. The rumen is suspended in a thermostatically controlled water bath at body temperature.

Under these conditions, the test meal in the rumen is fermented normally. Acetic, propionic, and butyric acids produced during fermentation accumulate in the rumen, and some of the acids are absorbed into the blood. The amount of each acid absorbed can be calculated from the difference between the concentrations in the blood before it enters and after it leaves the rumen. The acid production rate can be determined from the absorption rate and the amount of acid accumulated in the rumen during the perfusion.

An important discovery has been that the volatile acids are absorbed at rates which are in the same relative proportion as the concentration of the acids in the rumen (see table). This means that by measuring the concentrations of acids in easily obtained rumen samples, we shall be able to determine the relative amounts of acids made available to animals by different diets.

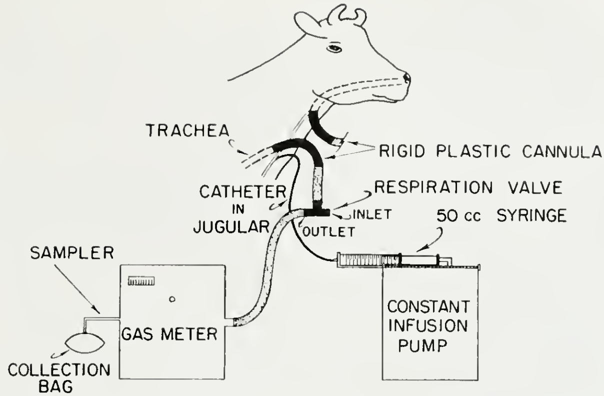
Efficiency of Energy Utilization

To predict the energy value of different feeds, we need to know not just the amounts of acids available to the animal, but also the efficiency with which these acids are converted into energy.

The energy contributed by a compound depends both on its fuel value and the amount that is oxidized. Combustible compounds absorbed into the blood may be oxidized to furnish energy, or used as raw materials for building tissue components such as meat or products such as milk.

When a compound is completely oxidized by animal tissues, one unit of carbon dioxide is formed for each unit of carbon in the compound. The carbon dioxide is carried in the blood to the lungs, and then given off in the expired air. Thus, by measuring the amount of carbon dioxide in expired air, it is possible to calculate the amount of combustible material that is being oxidized. However, several different compounds may be undergoing oxidation in the animal's body at the same time. To find out the energy produced by an individual compound, we need some method of identifying the carbon dioxide from that particular compound.

We have solved this problem by substituting a radioactive isotope (carbon^{14}) for one or more of the normal carbon atoms in a compound. When we inject the compound into the blood of the animal and measure the expired carbon dioxide, we can determine from the radioactivity of the CO_2 how much of the compound was oxidized to furnish energy. Methods of injecting the compound and measuring the expired air are shown in the diagram.



Methods of injecting radioactive compounds into a cow and measuring the expired air.

Acetic Acid Studied

The energy contribution of acetic acid or acetate has been studied in steers by the methods just described. We have found that ruminants can utilize large quantities of acetic acid and that the amount oxidized to yield energy increases as more acetate becomes available.

As the oxidation of acetate increases, the oxidation of other compounds decreases. Thus acetate can help to save compounds that may be used more profitably for forming meat or milk. From the estimated energy requirement of the animal, it has been calculated that the oxidation of acetic acid may supply 50 percent of the total energy. Clearly, the products of rumen fermentation are of major importance in supplying the nutritional requirements of ruminants.

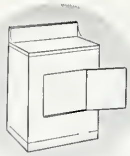
What We Still Need to Know

In recent years, ruminant nutritionists have discovered many chemical reactions that may affect feeds in the rumen. We now know that the rumen organisms will not always produce exactly the same compounds from a particular feed. Variations may depend on the physical form of the feed or the combination of other feeds in the ration.

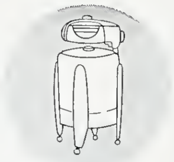
More work is necessary to predict the kinds of digestion products that we can expect from various rations and to evaluate the relative efficiency of these products for meat and milk production. There is little doubt that more efficient rations for various classes of livestock will be developed as new evidence is obtained.

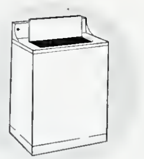
The goat rumen at left is being used to determine the rates at which organic acids are produced and absorbed into the blood during the digestion of alfalfa hay. Results obtained from a typical test are shown in the following table:

Acid	Acid increases during perfusion			Absorption rate	Production rate
	Rumen	Blood	Total		
	milligrams			*milligrams per minute*	
Acetic	5410	241	5651	1.85	43.5
Propionic	2390	124	2514	0.95	19.3
Butyric	1810	110	1920	0.85	14.8
Total	9610	427	10085	3.65	77.6



HOW 600 ILLINOIS WOMEN DO THEIR LAUNDRY





RUTH LEGG GALBRAITH
and MARJORIE LEACH

EVERY WEEK 51 million homemakers in the United States wash 1.5 billion pounds of laundry at home. How well they do this job affects both the appearance and serviceability of garments and household linens.

That's why an investigation of the laundry procedures actually used by a selected group of Illinois homemakers was undertaken in the Department of Home Economics. One hundred women from each of six counties — Du Page, Edgar, Jackson, Madison, Peoria, and Stephenson — were asked to fill out a detailed questionnaire containing 75 questions about their laundering methods. Of these women, 43 percent lived on farms and the others lived in towns.

These 600 women were asked about the hardness of water used and method of softening if soft water was used, type of washing machine, number of loads and frequency of washing, soaking procedure, type and amount of detergent used, washing temperatures, frequency of bleaching, type and amount of bleach used, number and type of rinses, use of bluing, fabric softener, or starch, drying methods, and ironing practices.

They were also asked for information about their families, including place of residence, number and ages of household residents, occupation, and annual family income.

Most Women Used Soft Water

When the answers to this questionnaire were sorted and tabulated, it was found that nearly two-thirds of the women used soft water of some kind. The urban women were more likely to have water softening systems, while the rural women were more apt to depend on cistern water or packaged water softeners.

Kind of Equipment

Of the 600 women, 59 percent used non-automatic washers, 36 percent used automatic washers, and 2 percent had combination washer-dryers. Forty percent had dryers.

Here again a difference was noted between urban and rural women. A larger percentage of the automatic washers were in town homes than in country homes, while most of the non-automatic washers were being used by rural women. However, rural homemakers owned seven of the nine washer-dryers reported.

No significant relationship was noted between age of homemaker and type of washing machine. However, the younger homemakers (18 to 30) were more likely to have automatic dryers than were the older women. And owners of automatic washers were more likely to have dryers than the women using non-automatic machines.

Young Women Washed Oftener

The main difference between the 18-to-30-year-old homemakers and the older women was that the younger group washed more loads per week and on more days a week. This was to be expected because they had larger families with more young children.

Too Little Detergent

Most of the women were using washing temperatures within the generally recommended ranges: 120° to 140° F. for white and colorfast cottons and linens; 100° to 120° F. for non-colorfast fabrics or fabrics containing synthetic fibers.

Very few women, however, reported using enough detergent to remove the soil effectively or to keep it from being redeposited during the washing process. Only 42 percent or 252 of the women accurately

Ruth Legg Galbraith, Associate Professor of Home Economics, has done much research on textiles and their care. The present article is based on a graduate study carried out by Marjorie Leach under Dr. Galbraith's direction. Miss Leach is now Assistant Home Economist with the Procter and Gamble Company. The authors wish to thank the six county home advisers and the 600 Home Bureau women who cooperated in this study.

Reach for the detergent and measuring cup instead of the bleach.

measured the amount of detergent used. And of these 252, 65 percent were using grossly inadequate amounts of detergent. Also, the women who were washing in hard water were not using any more detergent than those washing in soft water. Since synthetic detergents, as well as soaps, lose cleansing efficiency in hard water, a third to a half more should be used than would be used in soft water.

The most common type of detergent used was the heavy-duty, high-sudsing synthetic detergent such as Tide, Fab, Cheer, Rinso Blue, and Wisk. However, the women who had front-loading automatic washers were more apt to use low-sudsing detergents such as Ad, All, or Dash. They were also more apt to measure their detergent and to use the recommended amounts than were the women using other types of detergents.

Seventy percent of the women were using bleach regularly someplace in their laundry procedure, and an additional 5 percent used it sometimes. About 45 percent did this bleaching during the washing step while 29 percent bleached during a pre-soak.

Of the women who bleached their laundry, about 87 percent were using a liquid chlorine bleach. The women who bleached in a pre-soak were more apt to use a stain-removal concentration (as given on the bottle), while those who bleached during the washing process were more likely to use the amount recommended by the manufacturer for washing machine use. The articles bleached regularly were dish towels, sheets and pillowcases, underclothes, and children's clothes.

Recommended Changes

As indicated by the foregoing, most of the women were trying to bleach their clothes clean rather than use enough detergent to wash them clean. This was the most serious fault found in the women's laundering procedures.

Since any liquid chlorine bleach causes some loss of strength in cotton or linen fabrics, these women were inevitably sacrificing some durability to obtain clothes that were satisfactorily white. They could have removed much of the need for drastic and regular bleaching if they had put enough detergent in the washing machine. The amounts of detergent needed for good cleaning under various washing conditions are given in the table.

When bleaching is necessary to remove the yellowing and graying caused by repeated launderings (about every tenth wash), it should be done properly. Increasing either the amount of bleach used or the bleaching temperature will greatly increase the amount of fabric damage. Consequently, the directions on the package should be followed implicitly.

A stain removal concentration of a liquid chlorine bleach should be used only at room temperatures and only for stubborn stains. The washing machine concentration should be used for routine periodic bleaching. Concentrations lower than those recommended for the washing machine will not whiten clothes effectively.

All chlorine bleaches should be diluted before they touch fabrics. If a top-loading machine is used, the bleach should be added to the soak or the wash water and agitated before the clothes are put in the water. If a front-loading machine is used, the bleach should be diluted by adding 3½ cups of water to ½ cup of bleach before pouring it into the washer. It is also best to wait until the machine is completely filled with water before adding the bleach.

"Wash and Wear" Clothes in the Dryer

Another finding of the study was that many of the women who had dryers were not using them for as many types of articles as they could have. Only about half of these women, for example, put wash and wear clothes in the dryer, even though it has been demonstrated that, with proper use of the dryer, such clothes will be less wrinkled than if they are drip-dried. It is important that the heat setting should be warm (not hot) and that the garments should be removed from the dryer as soon as they are dry.

Amounts of Detergent to Use in Laundering

Detergent type	Trade names	Cups of detergent needed for— Top-loading washer: Soft water	Top-loading washer: Hard water	Front-loading washer: Soft water	Front-loading washer: Hard water
All-purpose soaps	Duz, Rinso White, Fels Naphtha	1½	2	1	1½
All-purpose synthetic detergents					
Low-sudsing	Dash, Spin, All, Ad*	¾	1	½	¾
High-sudsing	Fab, Cheer, Rinso Blue, Tide, Surf, Breeze, Oxydol	1½	2	1	1½

* Ad is less dense than the other three. To get proper concentration, double the amounts given.

A Program of Education in Public Affairs

L. H. SIMERL

In recent years farmers and other people have been increasingly confronted with a wide variety of public problems. These include not only farm price and income programs, but also taxation, schools, roads, zoning, foreign trade, national defense, and other problems of public concern.

The Cooperative Extension Service in Illinois is therefore undertaking a new experimental program of education in public affairs. Interest in public problems is, of course, not new for the Extension Service; it has been concerned with such problems ever since its establishment in 1914. In the earlier years, however, it concentrated its attention largely upon problems of the individual farm and home.

At present the project is being tried out in two pilot counties — DeKalb and Champaign. It was begun last July and is scheduled to continue through 1961. Principal purposes of the project are:

1. To improve the public affairs programs of the Extension Service in these counties.

2. To advance citizen education for public responsibilities.

3. To extend to other counties and states the useful knowledge gained from the experiences in the pilot counties.

The project was made possible by a grant of $40,000 from the Fund for Adult Education, which was set up by the Ford Foundation. Illinois is one of six states to receive such grants. The other states are Arizona, Michigan, Montana, Pennsylvania, and Texas. The Fund for Adult Education has given these states a perfectly free hand to plan and carry out their programs.

Choice of Pilot Counties

Extension Director L. B. Howard, Associate Director W. G. Kammlade, and Dr. H. G. Halcrow, Head of the Department of Agricultural Economics, chose the pilot counties. DeKalb and Champaign were selected partly because they are representative of the state and partly because the county Extension staffs are especially interested in educational programs in public affairs.

County Staffs Receive Assistance

Mr. E. E. Golden is farm adviser and Mrs. Jessie Nixon home adviser in DeKalb county. Mr. Earl Bantz and Miss Carol Rebbe are the advisers in Champaign county.

In planning and carrying out the public affairs project, the county staffs have at their disposal the services of the Extension specialists and other University staff members. In addition, a program consultant has been hired in each county to help with the project.

Mr. Carl McNair, the program consultant in DeKalb county, is a graduate of the University of Illinois College of Agriculture, and received his M.S. degree in agricultural economics from the University of Wisconsin in 1959. He has had experience in research, teaching, business, and farming.

Program consultant in Champaign county is Mr. LeRoy Rogers, a native Californian who was graduated from California State Polytechnic College in 1954 and received an M.S. degree in Business Administration from Oregon State College in 1958. His previous experience has been in farming and banking.

McNair and Rogers, together with the program consultants from the other five states, received special training for 11 weeks last summer at Michigan State University. Besides taking regular courses, they participated in special seminar discussions led by national authorities on adult education and public affairs.

The consultants also participated in a week-long Coordination Seminar in Texas last December. Several more training conferences will be held during the course of the project.

Counties Developing Programs

After moving to their respective counties in September, the program consultants concentrated on getting acquainted with the county Extension staffs, the Extension councils, and the leaders of various organizations and groups. They asked many questions to determine what community, state, and national problems were of most concern to the county people. They sought, too, to find out how the Extension Service could best help the county people find reasonable answers to those problems.

The people in DeKalb county decided that family relationships and community affairs (especially those of concern to young people) should receive first attention. The Champaign county folks felt more concern about farm price and income problems, and will concentrate on them in the beginning.

People Interested

Many organizations and individuals are keenly interested in the results of the project. Among them, for example, are University officials. The Federal Extension Service, too, is making careful observations of the project's development. Mr. J. L. Mathews of that office is especially concerned with the program planning and measurement of results.

Representing the Fund for Adult Education in the project are Mr. Robert J. Blakely, Vice President, Mr. Ronald Shilen, Executive Associate, and Mr. Frank Suggit, Project Coordinator.

Behind the widespread interest in the project lies an awareness that it may mark a major turning point in the development of the Cooperative Extension Service.

L. H. Simerl, Professor of Agricultural Economics, is state project leader for the pilot program in public affairs.

Meeting the Costs of Going to College

C. D. SMITH

LIKE ALMOST EVERYTHING ELSE, going to college costs more now than it did several years ago. A year at the University of Illinois (not counting recreation, travel expenses, or clothing) may cost anywhere from $1,000 to $1,500.

It's best to plan ahead to meet these expenses. Most college students have to use a combination of resources. These include contributions from parents, personal savings, earnings from part-time work while going to college, summer earnings, loans, and scholarships.

Parents' contributions usually come from current income. Less frequently parents have made provisions for meeting college expenses by means of insurance programs, savings, or other assets. More long-range planning would lessen the sacrifices that some parents have to make while their children are in college.

Personal savings of the student. Many students save some of their earnings from part-time or summer jobs while they are in high school, or from 4-H or FFA projects.

Part-time employment while in college is both common and feasible for many students of average or higher ability.

Summer earnings of college students can provide not only financial assistance but excellent experience as well. Depending upon the job and the individual, net savings may range from $300 to $800 a summer. Most students find that their summer earning capacity increases with each additional year of college and experience.

Loans. Borrowing money for a college education can be a good use of credit. It enables a student to pay for his higher education out of future income. Most colleges, many banks, and some foundations and individuals are providing this kind of credit. The National Defense Education Act has greatly increased college loan funds.

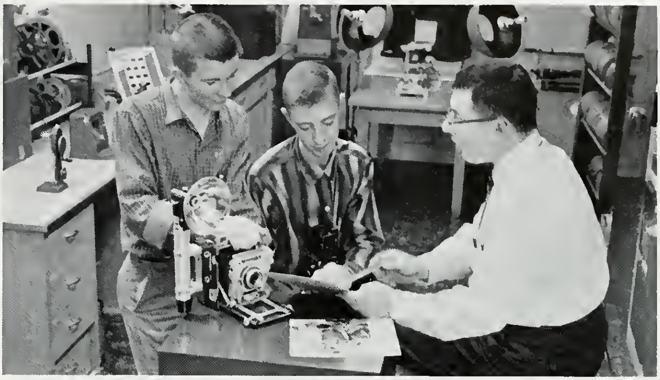
Scholarships, either tuition or cash, are awarded on the basis of academic ability and financial need. Most of them are worth between $150 and $500 per year. The average is $275.

Your high school principal or counsellor can tell you about the many scholarships that are available. Among them are County Tuition Scholarships and the scholarships awarded through the National Merit Scholarship Program and the Illinois State Scholarship Commission. In addition, each General Assembly member may nominate one student from his district for a four-year tuition scholarship at the University of Illinois.

Cash and tuition-waiver scholarships are also awarded by the Undergraduate Scholarship Committee of the University of Illinois. Applications and information may be obtained from Mr. D. A. Grossman, 105 Administration Building, University of Illinois, Urbana.

The College of Agriculture Scholarship Committee offers cash scholarships to students of agriculture or home economics. For information write to C. D. Smith, 104 Mumford Hall, University of Illinois, Urbana.

C. D. Smith is Assistant Dean of the College of Agriculture.



Glen Broom, an undergraduate student in agriculture, and John Woods, a graduate assistant in agricultural journalism, earn part of their college expenses by working with Jack Everly, Assistant Extension Editor, who is in charge of photographic service in the College of Agriculture.

COMING EVENTS

(A partial list of meetings scheduled at Urbana)

April 13-14: Grain Dealers' Management Conference

April 26-27: Illinois Bankers' Association — Agricultural Credit Conference

May 9-13: Leisurecraft and Counseling Camp (4-H Memorial Camp)

May 14: State FFA Awards Day Program

May 26-27: Production Credit Association Fieldmen's Conference

June 21: Illinois Crop Improvement Association Annual Meeting

June 22: Illinois Seed Dealers and Illinois Crop Improvement Association Tour, Agronomy South Farm

RESEARCH IN BRIEF

Why Most Soil Nitrogen Is Unavailable to Crops

The soils of Illinois generally contain 2,000 to 6,000 pounds of nitrogen per acre foot. Yet only a few pounds will be available to plants at any one time.

Most of the nitrogen occurs in the soil humus, which must be decomposed by microorganisms before the nitrogen is changed to mineral (available) forms. Evidently the humus nitrogen resists this change, but the reason is not well understood.

Recent research in the Department of Agronomy has shown that the stability of humus nitrogen is partly due to the interaction of humus with inorganic materials. Some humus was found to be combined with metallic ions, such as iron and aluminum. Other humus was adsorbed on the external surfaces and within the layers of clay particles. The formation of metal-humus and clay-humus complexes is nature's way of conserving soil nitrogen; otherwise the supply would soon be lost by leaching and denitrification.

Most Illinois soils do not provide enough nitrogen for maximum crop yields, particularly corn, and therefore need nitrogen fertilizer. To use commercial nitrogen most efficiently, it is necessary to know, with a reasonable degree of accuracy, how much nitrogen will be available from the soil humus during the growing season. A considerable amount of research has been done in an attempt to obtain a test for nitrogen, but no suitable test for Illinois soils has yet been developed.

It is hoped that the results obtained in this study will help in the eventual development of such a test. The study has shown that, to develop a test, soil scientists will need to consider not only the kinds and amounts of the various forms of humus in soils, but also the ways in which these forms are combined with mineral matter. — *F. J. Stevenson*

Disease-Resistant Corn Hybrids — Where Will They Come From?

Many disease organisms attack corn, causing substantial losses in yield and quality. The development of resistant hybrids is the most feasible method of controlling most of these diseases and thereby increasing production efficiency.

Through use of the many new techniques that have been developed for measuring disease resistance, some promising resistant corn strains have been obtained. But more hybrids with higher levels of resistance are needed. Where will they come from?

The inbred lines that make up our present-day hybrids have been derived from the open-pollinated corns grown by our forefathers. These inbreds capture some of the best germ plasm in the corn belt. They show striking differences in reaction to diseases, but few inbreds are resistant to more than one disease.

Conceivably inbreds with greater disease resistance could be developed from the open-pollinated varieties by applying greater pressure in the selection for resistance. The effectiveness of such procedures would depend upon the frequency of genetic factors for disease resistance in the variety being sampled.

The Department of Plant Pathology has grown 35 open-pollinated varieties in a disease nursery and evaluated their potential value as sources of disease resistance. Inoculations were made with *Helminthosporium turcicum* and *H. maydis*, causing northern and southern leaf blight respectively; and with *Diplodia zeae*, which causes stalk rot. Disease ratings were taken on about a hundred individual plants of each variety.

Results indicate that the following varieties would be promising sources of resistance to northern leaf blight: Boone County White and Yellow Dent from Missouri, Midland from Kansas, Jarvis Golden Prolific from Tennessee, Delta Prolific White from Arkansas, Hastings Prolific from Georgia, and Early King and Homedale from South Africa.

Most of the above varieties were resistant to southern leaf blight as well, as were also Blacks Yellow Dent from Iowa, Funks Yellow Dent from Illinois, Reids Yellow Dent from Indiana, and Leaming from Ohio.

Some plants resistant to stalk rot were found among most of the 35 varieties. The exceptions were early varieties which were growing out of their zone of adaptation.

Another source of good germ plasm is a collection of disease-resistant strains from Mexico, Peru, Guatemala, Yugoslavia, Ethiopia, Kenya, Australia, and other countries. Thus genes for disease resistance are scattered in corn types from many regions of the world. As most of these types are not adapted to Illinois, their factors for disease resistance need to be combined with corn belt germ plasm.

Besides contributing to the reservoir of germ plasm for disease resistance, these corn strains are providing valuable plant material for fundamental studies on the causes of disease, genetics, resistance, and methods of breeding. — *A. L. Hooker*

Can Laying Hens Be Debeaked?

Experience and experimentation have demonstrated that debeaking the immature pullet does not affect her potential to lay. But what about laying hens? Since the stresses that induce cannibalism may occur after production begins, egg producers who have not debeaked may have to decide whether to impose this added stress as a means of controlling cannibalism.

Experiments by the Department

Machine used for debeaking.

of Animal Science have probed this problem. In one experiment, four pens of 9-month-old White Leghorn pullets in 75 percent production were debeaked in January. One-half of the upper beak and the tip of the lower beak were removed and cauterized with an electric debeaker. During the ensuing months, these birds were compared with four pens of birds that hadn't been debeaked. No significant differences were found in body weight or production.

A second experiment involved White Leghorns of the same hatch and University of Illinois strains of Rhode Island Reds, New Hampshires, and White Rocks. Some birds of each breed were debeaked in October, January, and May, while control birds were not debeaked.

As in the first experiment, White Leghorns were not affected by debeaking in January. The same held true of debeaking in October and May. The three heavy breeds, however, showed significant decreases in weight and production after being debeaked in October and January, especially in January. Rhode Island Reds appeared to be most sensitive. White Rocks and New Hampshires were about equal to each other. None of the breeds was much affected by debeaking in May.

The following points should be considered in interpreting these results: (1) experiments were conducted in an environment devoid of the stresses that induce cannibalism; (2) different strains of the same breeds might have reacted differently in the same environment; and (3) the same strains might have reacted differently in another environment.

Our research has shown that midwinter debeaking will not affect egg production under the proper combination of stock, procedures, and environment. Further experimentation is needed to define more adequately the limits of this "proper combination." — *D. J. Bray*

Our Shifting Population

As we enter the decade of the sixties, another complete census of the population is getting underway.

Most of us are aware that population has grown tremendously since the 1950 census. It is estimated that the population of Illinois is now about 10.3 million, or 1.6 million more than in 1950. This is the largest 10-year increase in the state since the first census in 1820.

As important as the population increase is the changing distribution. The greatest increases are in and around the state's largest cities. We estimate that more than 90 percent of the total growth in the past 10 years has been in Cook, Du Page, Kane, Lake, Macon, Madison, Peoria, Rock Island, Sangamon, St. Clair, Tazewell, Will, and Winnebago counties.

This trend has been going on for some time. Between 1900 and 1950, slightly more than 80 percent of the state's total growth was in the 13 metropolitan counties listed above. The trend was speeded up during the forties, largely because of the war and the rapid technological developments in agriculture that resulted in heavy migration from farms. In that decade, the 13 metropolitan counties accounted for more than 95 percent of total population growth.

The 1960 census will no doubt show small increases in some nonmetropolitan counties. Others, however, chiefly the most rural, have been declining. Between 1940 and 1950, 56 counties decreased in population. More counties can be expected to show declines in this year's census.

The farm group will be the smallest ever recorded in Illinois — about 610,000. Farmers and their families will be not only a small minority of the total population, but also a minority of all rural residents.

The dramatic shift in population will pose many questions as to the best ways of providing for schools, churches, medical care, and other needs. The rapidly growing counties will have to draw heavily on local resources to expand present services and provide new ones. Declining counties will be forced to readjust and perhaps eliminate some services. This will require reorganization of local units responsible for providing particular services. — *C. L. Folse*

Timber Prices Are Reported for Illinois

Timber covers some 4 million acres in Illinois, and the sale of primary forest products alone amounts to about a million dollars a year. There is thus a need in this state for forest products price information, similar to the crop price information that has been available to farmers and other interested people.

Only in recent years, however, has information on forest prices in Illinois become generally available. It is contained in "Timber Prices," a publication issued twice a year through the cooperative efforts of the U. S. Agricultural Marketing Service, the Illinois Department of Agriculture, and the Illinois Technical Forestry Association.

For this report, the state has been divided into four zones on the basis of similarities in forest conditions, utilization practices, and price ranges. Both average prices and the range in prices are reported by zone and year for the principal commercial forest products marketed in Illinois. In addition, some comparisons are made of current timber prices and those prevailing in previous years.

The Department of Forestry, University of Illinois, has done research to help develop the present system of collecting and compiling timber price information, and has also obtained basic price data. After four years of price reporting, procedures are again being studied to see if further improvements can be made.

Timber price information for Illinois can be secured directly from the Department of Forestry, University of Illinois. To receive "Timber Prices" regularly, write to the U. S. Department of Agriculture, Agricultural Marketing Service, P. O. Box 429, Springfield, Illinois. — *I. Irving Holland*

Auger Lifts Liquid Manure

The auger has been used for many jobs around the farm. Its latest use is for lifting liquid manure from storage to a spreader.

The Department of Agricultural Engineering has recently run tests on augering water. A standard 6-inch auger tubing, 11 feet long with 5-inch flighting, was modified by welding a 6 x 2 x ¼ inch steel plate on each side of the shaft at the outlet. This was necessary to force the water out of the auger.

The auger was tested by varying (a) the amount of flighting exposed at the inlet, (b) the speed, and (c) the angle of incline of the auger. The exposed flighting was varied from 0 to 14 inches. The greatest quantity of water was lifted when the flighting was completely covered. Subsequent tests were made, however, with 5 inches exposed so that more viscous fluids could enter.

The speed of the auger varied from 800 r.p.m., the minimum speed required to raise the water, to 1,450 r.p.m., the maximum the test motor would deliver. These tests were run at 45, 60, 75, and 90 degrees slope of the auger. The graphs below show the power consumption and water output for various speeds and auger positions. — *H. H. Klueter*

Sweet Corn Varieties for Illinois

Sweet corn is an important crop for both commercial vegetable growers and home gardeners in Illinois. For the greatest profit or eating pleasure, varieties best suited to a particular situation should be selected.

Each year many new varieties (hybrids) are introduced, and the more promising ones are evaluated in the state by the Department of Horticulture. In 1959 trial plots were located in the East St. Louis area, in Cook county, and at Urbana.

Varieties which looked good in these trials are discussed below. Some have been recommended for several years, but others are being suggested for the first time. All have yellow kernels and are considered maincrop varieties (normally maturing in 80 to 85 days).

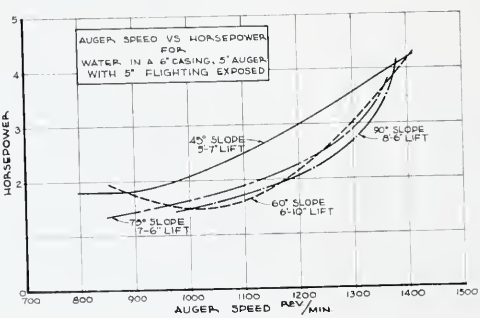
Victory Golden, which has been grown in Illinois for some time, is still highly recommended for canning, fresh market, and home garden use. It has excellent quality and yields well, often producing two good-appearing ears per stalk. Ears are usually a little over 8 inches long. Where bacterial wilt is a problem, precautions should be taken to control flea beetles (which carry the bacteria causing this disease) since this variety has only fair resistance.

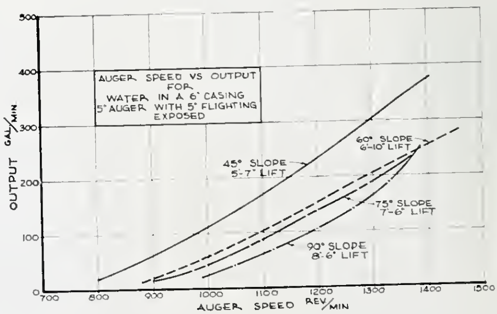
Gold Cup is a new, high-yielding variety with good quality. Ears are good-looking and well-filled, but, being 7½ to 8 inches long, they are too short for some markets. Where Golden Security is grown for fresh market and shipping, Gold Cup should be given a fair trial. It also makes a good home garden sweet corn.

Golden Sensation, which is becoming popular as a processing variety, has possibilities as a fresh market corn and is definitely a good variety for the home garden. It has very good eating quality. Ears are usually over 8½ inches long and appear slim because of their small cobs. Every commercial grower in Illinois should give this variety a try.

NK 199 is used mainly for processing but shows some promise for roadside stands and home gardens. It produces a large pointed ear (over 2 inches in diameter and 7 to 8 inches long) with 20 rows of kernels. High quality, along with narrow, deep kernels, makes this corn an enjoyment to eat. The ear tips are not well protected and are therefore susceptible to bird and worm damage. Yields are only fair.

Golden Prolific is worth trying where the market wants a long ear.





The ears are usually over 9 inches long. Ear tips are not too well protected by the husk, allowing worm and bird damage, but the unhusked ears usually have good appearance. Yields and quality are acceptable.

Golden Security, a standard variety in most commercial areas, is a heavy yielder, good for shipping only. It has an attractive ear with a good protective husk, but its eating quality is poor and for some markets its ears (about 8 inches long) are too short.

For more information about these varieties and others that can be grown in Illinois, write the Department of Horticulture, University of Illinois, Urbana. — *Norman F. Oebker*

Pinch Hitting for Protein

Rations that will give maximum performance at minimum cost are the eventual goal of research in animal nutrition.

Protein is usually one of the more expensive components of livestock rations. Simple-stomached animals such as man, swine, and poultry require preformed protein in their diet. Ruminants such as sheep and cattle, however, can utilize certain non-protein nitrogen compounds (NPN). Microorganisms in the paunch change the NPN into forms of protein that can be digested by the animal.

Urea is widely used in ruminant rations as a source of NPN when relative costs of protein sources make it appropriate to do so. There are certain limitations to the use of urea. It may be toxic if consumed in large amounts during a short period of time. Furthermore, it is not well utilized unless it is combined at frequent intervals with a source of readily available energy.

In an attempt to make the use of NPN in sheep and cattle rations more flexible, the nutritional value of biuret (formed when urea is heated) is being studied.

Tests have shown that biuret is relatively non-toxic to sheep on either an acute or a cumulative basis.

These sheep are near the end of a 596-day period during which most of the nitrogen in their ration was supplied by biuret. They show no evidence of damage from this ration.

Sheep have matured and produced lambs during a 596-day period when biuret supplied more than half the nitrogen in the ration. Wool from these sheep appeared normal.

Utilization studies have shown that sheep and steers retain about as much biuret nitrogen as urea. Also, on complete self-fed rations, the two forms of nitrogen are utilized with about equal efficiency. Biuret, however, appears to be better utilized when rations are fed at relatively widely separated intervals as would occur in supplemental feeding of range stock or breeding stock.

When animals are put on a new ration containing biuret, they go through an adjustment period similar to the adjustments involved when they change to or from pasture.

At present biuret is relatively expensive to produce and is not being fed commercially except as it appears in some commercial urea. It would seem from these studies, however, that greater flexibility has been added to our production potential for ruminant livestock. — *U. S. Garrigus, E. E. Halfield, R. M. Forbes*

Truck Shipments of Grain From Country Elevators

Transportation is one of the major costs in marketing grain. In the last 25 years, particularly since World War II, we have moved rather rapidly from total dependence on railroads to a choice, in many cases, between rail and truck.

During the 1957 crop year, country elevators in Illinois handled an estimated 531 million bushels of grain. About 57 percent was corn, 24 percent soybeans, and the remaining 19 percent about equally divided between wheat and oats. How the grain was disposed of is shown in the following table:

Grain	*Percent sold locally*	*Percent shipped by—*		
		Rail	*Truck*	*Barge*
Corn	16.3	48.2	35.2	0.3
Wheat	3.8	62.2	32.0	2.0
Oats	23.6	36.6	39.8	0
Soybeans	1.7	69.2	27.9	1.2
Total	12.3	53.4	33.6	0.7

The figures given for barge shipments include only the grain shipped directly from the elevators. Most barge grain is first trucked from country elevators to river subterminals.

Both the volume and the percentage of grain shipped by truck were greater in 1957 than in 1954 or 1956. The following table shows how the three years compared:

Grain	*Shipped by truck in—*		
	1954	*1956*	*1957*
Corn			
1,000 bu.	59,380	74,554	106,051
Percent	32.9	27.2	35.2
Wheat			
1,000 bu.	7,170	14,645	16,954
Percent	20.6	26.4	32.0
Oats			
1,000 bu.	12,150	14,788	20,370
Percent	30.4	34.1	39.8
Soybeans			
1,000 bu.	13,430	32.380	35,115
Percent	21.4	25.8	27.9
Total			
1,000 bu.	92,130	136.367	178,490
Percent	29.0	27.4	33.6

Detailed information on the 1957 crop movement, including figures for seven areas within the state, is available in a mimeographed research report, *Truck Shipments of Grain in Illinois, 1957.* It may be obtained from the Department of Agricultural Economics. — *C. P. Schumaier*

FARM BUSINESS TRENDS

The price of Illinois farmland has made three great swings in this century. There was a 20-year upswing from 1900 to 1920, a 13-year descent to 1933, and the great 26-year rise to 1959. These swings in land values have followed big changes in cash receipts from farming. Figure 1 shows changes in the value of Illinois farmland since 1900, and cash receipts from Illinois farms since 1924.

Two events lifted prices from 1900 to 1920: first, an increase in world gold production, resulting from newly discovered deposits in Alaska and Africa; and second, World War I.

After 1920 many countries tried to restore prewar price levels and monetary values. These efforts greatly depressed world prices of agricultural products. Prices of United States farm products dropped very sharply in 1920 and 1921, leveled off until 1929, then declined until 1932.

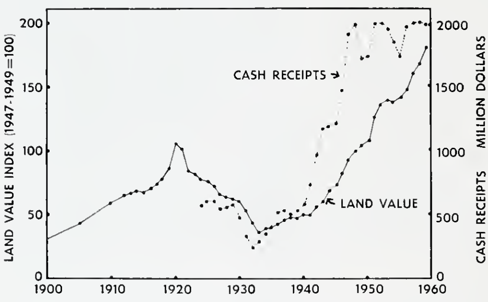
Prices began an upward climb after 1932 for two reasons: (1) The dollar was devalued or cheapened in 1933. (2) Extreme drouth prevailed in the Great Plains and other areas from 1933 through 1936.

The price rise was accelerated during the 1940's by inflation growing out of World War II. Prices dropped about a fourth in 1948 and 1949 but made a strong recovery during the Korean War.

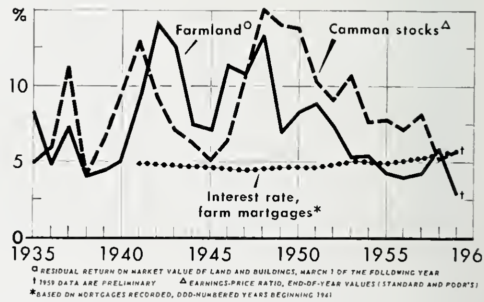
Through the 1940's land values lagged far behind prices of farm products. This made it possible for land values to continue rising in the 1950's even after cash receipts had leveled off.

Figure 2 shows a comparison of the returns on market values of common stocks and United States farmland from 1935 through 1959. The return on common stocks is an actual return, while the return on farmland is calculated or estimated. Two points may be noted: (1) People are apparently willing to take a lower rate of return on farmland than on common stocks. (2) The calculated rate of return on farmland was well below the interest rate on farm mortgages in four of the past five years.

The U. S. Department of Agriculture reports that from last July to November Illinois farmland values declined about 1 percent although national farmland values increased 1 percent. Sales have become very slow. Prices now seem to be \$25 to \$50 an acre lower than they were last summer. — *L. H. Simerl*



Illinois value of farmland per acre, 1900-1959, and cash farm receipts, 1924-1959. (Fig. 1)



Return on the market value of common stocks and of United States farmland, 1935-1959. (Fig. 2)

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Summer, 1960

ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

IN THIS ISSUE

Completely automatic feeding is proving itself on the Warren Frye poultry farm in central Illinois (page 10).

Volume 2, Number 3 UNIVERSITY OF ILLINOIS COLLEGE OF AGRICULTURE URBANA, ILLINOIS

ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

CONTENTS

Summer, 1960 Volume 2, Number 3

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RESEARCH IN THE DEPARTMENT OF AGRONOMY

seeks a more complete understanding of the soils and crops upon which Illinois agriculture is based. As agricultural technology develops, farmers are confronted with an increasingly wide choice of fertilizers, varieties, herbicides, and tillage methods. A major objective of the Agronomy research program is to provide the kind of factual information needed to make sound choices among these alternatives.

A statement made by President Draper in 1904 — "The wealth of Illinois is in her soil and her strength lies in its intelligent development" — serves as an inspiration for the strong research program in all aspects of soil science. This program includes the work of the Illinois soil survey, field and laboratory studies on soil fertility and plant nutrition, and basic studies of the physical, chemical, mineralogical, and biological properties of Illinois soils.

Improved varieties of corn, soybeans, small grains, and forage crops, as well as better cultural practices, have come from research by the Agronomy Department. Fundamental studies in genetics, physiology, developmental morphology, and biochemistry continue to reveal new facts about the growth of plants and their response to their environments. These facts are the building blocks with which future agronomic achievement will be constructed.

Research in Agronomy applies the principles and techniques of the fundamental physical and biological sciences to studies of the properties of soils and crops. Agronomists, working with their colleagues in other agricultural fields, use the information gained from such research to help solve problems encountered on the farms of Illinois. — *M. B. Russell, Head of the Department*

Dr. Russell has held his present position since 1951. Previously he was on the staffs of Cornell University and of Iowa State University, where he received his Ph.D. degree in 1939. He has written many articles and books on soil science, and is program chairman for the Seventh Congress of the International Society of Soil Science, to be held in Madison, Wisconsin, in August.

GIANT FOXTAIL . . .

A Robber in Your Fields

ELLERY KNAKE

It's easy to spot giant foxtail in corn and soybean fields (Fig. 1). But it's not so easy to see how much this silent thief is taking from the growing crop. Now after three years of research at the University of Illinois we have data which can help farmers estimate the losses in yield that are caused by giant foxtail.

The studies were conducted from 1957 through 1959 at the Agronomy South Farm at Urbana on a good corn belt soil — Drummer silty clay loam. Corn and soybeans were grown using practices commonly employed by many Illinois farmers. The areas between the corn and soybean rows were kept free of weeds, but various amounts of giant foxtail were left growing directly in the rows with the crops.

Corn plots with a band of 50 giant foxtails per foot of row yielded about 71 bushels an acre, while weed-free check plots yielded about 94 bushels. (Fig. 2)

The weeds in the rows were thinned by hand to give the numbers of weeds desired for the study. After thinning, the heaviest stand averaged about 50 giant foxtail plants per foot of row. The lightest stand was one foxtail plant every 2 feet. One series of plots was kept weed-free to serve as a check (Figs. 2 and 3).

Differences Not Apparent Until Harvest

As we looked at our corn plots in the summer, it was difficult to observe much difference in the growing corn whether weeds were present or not. The real differences showed up at harvest time when we weighed the ears and took yields. The reductions in yield are shown in Table 1.

At first glance, it was also hard to detect differences in the soybean plots. Soybean plants were only 2 or 3 inches shorter where 50 weeds were growing per foot of row than where there were no weeds. We did, however, observe differences in the number of pods per plant. Where the foxtail shaded and competed with the beans, the soybean plants had fewer pods than in the weed-free plots. Fewer pods meant fewer beans and hence fewer bushels per acre. Here again the real differences showed up at harvest time (Table 1).

Watch for this culprit — giant foxtail, alias wild millet. It can be recognized by its nodding seed heads, the fine hairs on its upper leaf surfaces, and a height of up to 6 or 7 feet. (Fig. 1)

Total plant material above the soil surface was harvested, including weeds, soybean straw, and corn stalks. We found that any increase in dry matter from the weeds was roughly proportional to a comparable decrease in dry matter from the crop. What we gained in weeds on the soybean plots, we lost in straw and beans (Fig. 4); any increase in weeds in corn was compensated for by less stalks and grain (Fig. 5).

This research indicates that on a given acre of Illinois farm land there are enough nutrients, moisture, light, and heat energy available to produce a certain amount of dry matter. The material and energy used by the weeds cannot be used also by the crops.

Even when we used high amounts of fertilizer and had very high amounts of rainfall, crop yields could not be maintained at maximum levels as long as weeds were present.

Average soybean yield was 28 bushels an acre on plots where a band of 50 giant foxtail plants was left growing per foot of row. Check plots with no weeds averaged 39 bushels an acre. (Fig. 3)

Estimate Your Losses

This summer you can estimate yield losses due to competition from giant foxtail. Go into a corn or soybean field and count the number of foxtail plants per foot of row in several places. Calculate the average. Now compare your count with those in Table 2 and estimate the loss in yield. For example, if you find an average of six giant foxtail plants per foot of row in a corn field, the estimated yield loss is 12 percent. If you are aiming for 100-bushel yield, you're losing 12 bushels due to weeds.

After you have determined how much your weeds are costing in reduced yields, you will be in a good position to decide how much you can afford to invest in improved weed control.

Follow a Good Control Program

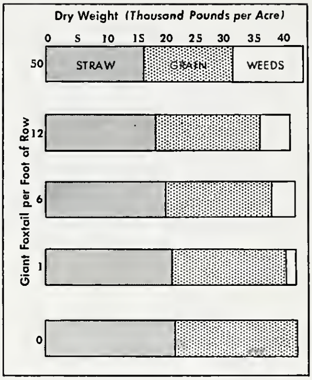
The following punches will help knock out weeds:

1. Plant corn and beans after soil temperatures are warm enough to help the crop get off to a good start ahead of the weeds.
2. Plant corn in checked rows. If you prefer hill-dropping or drilling, you should be willing to place emphasis on other control measures.
3. Use pre-emergence herbicides for serious weed problems.
4. If no pre-emergence herbicides have been used, or if they haven't been successful, use a rotary hoe when weeds are small.
5. Do a good job of cultivation. Throw soil into the row to cover the weeds but not the crop.
6. Use post-emergence applications of 2,4-D.

Table 1. — Effect of Various Stands of Giant Foxtail on Corn and Soybean Yields (3-year average, 1957-1959)

Foxtail plants per foot of row	Corn yield	Soybean yield
	bushels per acre	
50	70.6	27.6
12	78.4	31.9
6	82.1	34.6
3	85.0	36.2
1	86.4	36.8
½[a]	90.4	37.1
Check, no weeds	93.5	38.5

[a] One weed every 2 feet.



Effect of giant foxtail on dry matter produced by soybeans. (Fig. 4)

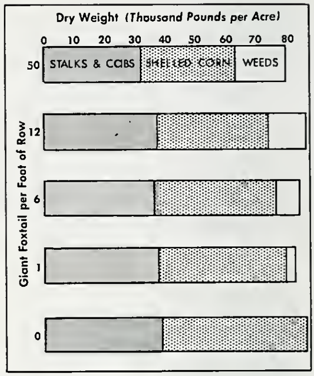
Good cultural practices such as use of the rotary hoe and good row cultivation are still among our most economical and practical methods for controlling weeds. But when heavy rains after planting delay cultivation, little weeds soon become big ones. When this happens, cultivation can still eliminate most of the weeds between the rows but not the big weeds growing in the rows.

Although post-emergence application of 2,4-D will destroy many broad-leaved weeds in corn rows, it will not kill grass weeds like giant foxtail. And 2,4-D is of little help in controlling weeds in soybeans since soybeans are susceptible to it.

Table 2.—Percent Reduction in Corn and Soybean Yields Caused by Giant Foxtail (3-year average, 1957-1959)

Foxtail plants per foot of row	Percent reduction in yield: Corn	Percent reduction in yield: Soybeans
50	25	28
12	16	17
6	12	10
3	9	6
1	7.5	4.5
½[a]	3	3.5

[a] One weed every 2 feet.



Effect of giant foxtail on dry matter produced by corn. (Fig. 5)

The research chemist and plant physiologist have given us new tools to help prevent weeds from growing in the row with corn and soybeans. These are the pre-emergence herbicides. They are applied before the crop or weeds emerge — usually at planting time. However, they may cost \$2 to \$5 an acre even when applied only in a 12- to 14-inch band directly over the row. Farmers are asking, "Does such an investment pay?"

Whether any weed control practice will pay depends on the seriousness of the weed problem and how much good can be expected from the control measure. A farmer who spends extra money for weed control when he doesn't have a weed problem would be like the Eskimo who bought an ice box. But the farmer who has a weed problem and does not invest in needed weed control is like the poultryman who tried to save money by starving the goose that laid the golden egg.

E. L. Knake has been Assistant Professor of Field Crops Extension since February, having previously been Instructor in Vocational Agriculture. This article is based on research that he did for his Ph.D. degree, which he received this year.

Better Drainage for Claypan Soils

C. K. MARTIN and A. L. LANG

New possibilities for improving the drainage of claypan soils have been suggested by experiments at Carbondale and Brownstown.

The Carbondale experiment was set up at the Agronomy Cooperative Research Center in 1958 with the cooperation of Roy Browning. Eighteen plots, each 1 square rod, were heavily fertilized and limed. In addition, different plots received various combinations of extra lime, manure, and chiseling to a depth of 18 inches so that the effects of these variables on drainage could be studied. Legumes were seeded on all plots, and night crawler earthworms were introduced.

Deep drainage is provided by holes 10 feet deep and 4 inches wide in the center of each plot. The water level in these holes is usually kept down to about 4 feet. Holes 3½ feet deep are located between the deep ones to check the water table.

So far we have not seen any results from chiseling or from manure or heavy lime applications. Very early in the experiment, however, we noticed that the water level would drop faster in the 10-foot holes than in the 3½-foot holes. This raised the question as to whether deep holes would improve the drainage in the areas surrounding them. We also wanted to know how far from a tile line the water level in deep holes would be affected. An experiment was therefore set up at Brownstown to answer these questions.

A tile line 5½ feet deep and 200 feet long was established through an area that is difficult to drain. Seven rows of nine holes, each 14 feet deep and 5 inches wide, were drilled in the area parallel to the tile line with the sixth row touching the tile. The holes were 20 feet apart each way. They were capped at the top, 1 foot below the surface, so that water could move in and also the field could be plowed. Three rows of 3-foot observation holes were dug perpendicular to the tile line, permitting measurement of the water table. As at Carbondale, the soil was seeded to legumes after being fertilized and limed; and night crawlers were introduced.

Several times during the past winter at Brownstown, the water level in the area of the deep holes dropped as low as 20 inches within 8 days after saturation (see chart below). During the same period the water level dropped only 11 inches in an adjacent area that had similar drainage conditions but no deep holes.

Deep holes 100 feet from the tile have provided drainage for the areas around them. Some holes do better than others, with little relationship to distance from the tile.

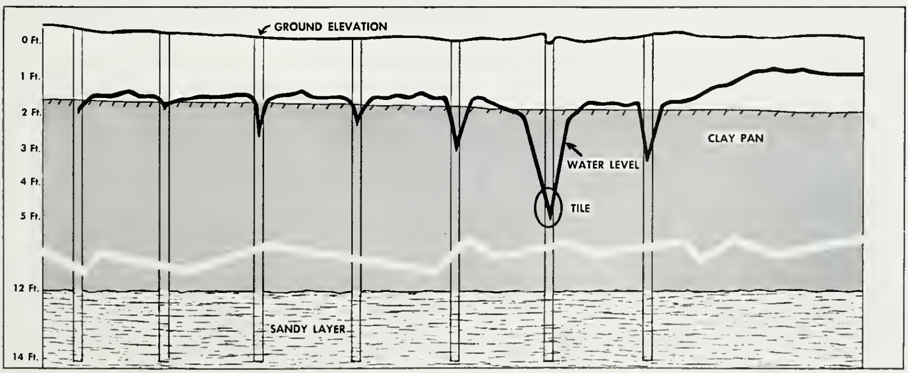
This past spring, the soil on the Brownstown plots was disked and seeded on April 8, 10 days after complete saturation from spring thaw. On the same day, surrounding fields, which had previously been better drained, either were disked with much difficulty or could not be disked at all. Since then, the plots could always have been worked within 4 days after a rain. This was not true of some of the nearby fields.

Night crawlers have survived two winters at Carbondale and one at Brownstown. They have penetrated as deep as 28 inches at Carbondale and could be affecting drainage.

Although the use of deep holes has given encouraging results, more work is necessary before we can make positive recommendations.

C. K. Martin is Assistant in Agronomy, and A. L. Lang is Professor of Soil Fertility.

Water level on the Brownstown drainage experiment plots, January 5, 1960. On the previous December 28, the soil was saturated and the water level was at the surface. Rainfall since December 3 had totaled 2.88 inches.



A specified number of pigs ready for market at the same time would be one advantage of controlling the farrowing dates of hogs

By PHILIP DZIUK

Can We Control the BREEDING DATES OF ANIMALS?

POULTRY RAISERS can now routinely place an advance order for a large number of chicks of a certain age to be delivered on a specific date. But producers of other types of livestock must still be content to have young animals presented to them at any time of day or night over a period of at least several weeks.

Advantages of Synchronizing Livestock Births

Many farmers, I am certain, have wished that the time of livestock births could be restricted to a few days, thus cutting down on the period of night-time vigils with expectant females. Added to this convenience would be other advantages: Since the offspring would be of uniform age, they could be more easily handled, fed, and sold as a homogeneous group. (Imagine the advantage a seller would have if he could guarantee a specific number of market animals of a certain age on a certain date.) Facilities could be used more efficiently if it were possible to plan for a certain number of young at a certain time. If 2- or 3-week intervals were allowed between birth dates of groups of animals, proper sanitation procedures could be carried out between groups to help break a disease chain.

A small convenience at the time of breeding would be realized by having animals in heat only during mid-week, thus avoiding extra work on weekends. Artificial insemination would be more practical if plans could be made to inseminate a large number of females in one or two days. Storage of semen would be less of a problem if heat dates were known in advance.

Up to now we haven't been able to realize these possibilities because heat cycles normally occur at random in a group of animals. We can therefore count on only a small proportion of a group to be in heat on any one day. What we need is a treatment that will synchronize heats.

Kind of Treatment Needed

A satisfactory treatment for synchronizing heats must have several qualities. First, it must be effective. For if animals don't mate, ovulate, and conceive and bear young following treatment, it is useless. Second, it must be easily administered. Repeated injections or complicated procedures would mean more extra work than most farmers would want to put into this aspect of the livestock enterprise. Third, the treatment should be relatively cheap. Any possible advantages would have to be weighed against the cost.

For a treatment to be effective, ovulation of one or more eggs must quite closely coincide with heat so that the sperm and egg may meet at a precise time and fertilization can take place. Ovulation without heat is unsatisfactory because the female never mates. Heat without ovulation is just as bad because the female will mate but can't become pregnant.

Some Treatments Tried Unsuccessfully

Treatments involving one or more injections of estrogens (female sex hormones) will almost invariably cause heat in 24 to 48 hours, but they do not cause ovulation. Hence,

such treatments are useless, if not harmful, even though mating takes place.

Various other hormones can be injected that will stimulate the ovary to produce eggs, but they often do not induce heat. Furthermore, some eggs produced by this treatment are defective and cannot be fertilized. Hence another relatively ineffective treatment.

Many farmers have used certain management practices, such as weaning the pigs from a group of sows simultaneously, to synchronize heats. This method, however, does not usually work with gilts nor with most other classes of livestock.

Injections of Progesterone Effective but Impractical

One of the most effective treatments for synchronizing heat in a group of animals involves injections of the female sex hormone, progesterone. This hormone is normally secreted by the ovaries during pregnancy and during the part of the heat cycle when the animal is not in heat.

How can a hormone which keeps an animal out of heat be used for heat synchronization? First, all animals in a group are injected every day for a week or two and thus are kept out of heat. Then the injections are stopped on all animals on the same day. About 4 days later most treated animals come into heat and ovulate. This method is a little like a starting gate at a race track. Since all animals are held so that they will start at the same time, they will tend to be bunched at the first turn.

The work and inconvenience of daily injecting each animal for a week or more makes this method too costly and cumbersome to be practical. Other materials that prevent heat but are longer acting have been tried. While they do away with the need for daily injections, they don't open the "starting gate" for each animal at the same time. Thus heats are not well synchronized.

Progesterone Tried in Rations

The most promising approach to the problem is that of incorporating progesterone, or a chemical derivative of progesterone, into the diet. Experiments are being conducted at the University of Illinois, as well as some other experiment stations, to develop this method so that it can be used by livestock farmers.

The progesterone material is mixed into the ration at the rate of a few teaspoonfuls per ton of feed. Females to be bred are fed this treated feed for 16 to 21 days and then returned to their normal diet. Most of them will come into heat, ovulate, and mate 3 to 5 days after they quit getting the progesterone.

Preliminary work has been done with many mice. About 70 percent have mated and conceived on the expected days. The litter size has been normal, indicating that the treatment did not interfere with normal reproductive processes.

Several trials with about 100 pigs have given us encouragement that the treatment may work with larger domestic animals, although results thus far have not been as consistent as with the mice. Several different amounts of hormone have been fed in attempts to determine the optimum level. Both hand-feeding and self-feeding have been used. Several other variations of management and diet have been tried also.

In our experiments, about 60 percent of treated gilts have come into heat and mated on the third, fourth, or fifth day after treatment was stopped. Twenty percent have come into heat some time later than that, and the other 20 percent did not breed. The latter group also showed some abnormality, such as cystic ovaries, which was due in part to the treatment.

Some gilts were killed 50 days after breeding to examine the ovaries and uterus and to count the fetuses. Gilts allowed to farrow produced litters of normal size.

Another indication of the treatment's effectiveness was exhibited by the farrowing of one group of 10 gilts. Seven of them farrowed in a 48-hour period. This period happened to be on Monday and Tuesday, reminding us that mid-week farrowings may be an extra bonus if the treatment can be perfected.

Problems To Be Solved

Many problems remain to be solved before Illinois farmers can predetermine the breeding and birth dates of their livestock. For one thing, results should be more consistent. Although 60 percent of all treated gilts came into heat when expected, this was not true of every group. Sometimes only 30 percent of a particular group would come into heat on the expected dates. Another problem is to determine the cause of cystic ovaries, so that this undesirable effect can be overcome or lessened.

We need to show that the material added to the feed is safe and not contrary to pure food and drug restrictions. Ways must be found to reduce costs, which are still quite high. And we need to know more about methods of feeding—whether once-a-day hand-feeding is satisfactory or whether self-feeding or more frequent feedings are necessary. The level of progesterone that each animal eats must be determined, and this probably depends on age, weight, degree of fatness, nature of the diet, and perhaps some environmental factors. Experiments are now being conducted in an effort to understand and control these variables.

If all these problems can be solved, we may some day be able to "put in our order" for young livestock and obtain them on the date we want them.

Philip Dziuk came here in 1955 after receiving his Ph.D. degree from the University of Minnesota. He is Assistant Professor of Animal Physiology.

AUTOMATION in the CATTLE FEEDLOT

ROY VAN ARSDALL

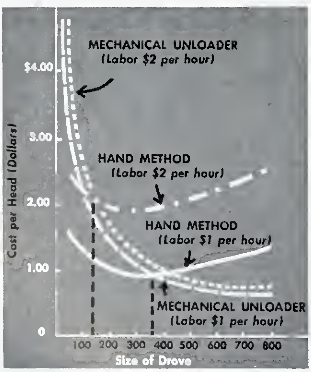
TECHNOLOGY has created new equipment that reduces the labor and cuts the cost of handling feed for beef cattle. As the number of possible feeding methods increases, however, the problem of choosing the most economical one becomes more complicated.

U. S. Department of Agriculture economists, cooperating with the Illinois Agricultural Experiment Station, have been studying the economics of different kinds of equipment in cattle-feeding operations.

A recently completed study analyzes important alternatives for handling steer calves fed corn silage and concentrates in drylot for 330 days. It was assumed that the farmer was free to build an efficient layout without hindrance from existing buildings. Chief jobs considered were getting feed out of storage and moving it to the cattle.

Unloading Silage

Removing silage from an upright silo is a difficult task when done by hand. The high rank that it takes in the list of disagreeable livestock chores is indicated by the large numbers of mechanical unloaders on farms too small to justify an unloader economically.



Annual labor, power, and equipment cost of two methods of removing corn silage from upright silos. (Fig. 1)

A comparison of the costs of unloading silos by hand and by machine is given in Figure 1. Two main points are brought out: (1) The importance of having enough volume over which to spread the high fixed costs of the machine method, and (2) the influence of the labor rate in determining the least-cost method.

When labor is figured at $1.00 an hour, nearly 350 beef cattle are necessary to justify an unloader for corn silage. Increasing the value of labor to $2.00 greatly raises the cost of the hand method. The machine method then becomes a reasonable alternative with about 150 cattle. The value of labor has little effect on the cost of the machine method, as shown by the small shift in the unloader cost curves.

Grass silage is harder to handle than corn silage; so the break-even points between methods come at lower volumes.

Investment in Distributing Systems

Farmers can choose from at least a half dozen methods for distributing feed. Most are independent of the method of removing feed from storage. Four systems for finishing steer calves in drylot were analyzed in this study. The equipment for delivering feed included a basket, ordinary wagon, self-unloading wagon, and mechanical bunk feeder.

These four systems varied considerably in the amount of investment necessary (Fig. 2). Outlay for the basket and ordinary wagon systems was mostly for feed bunks.

The cost of self-unloading wagons was figured at $1,400 to $2,400 depending on the number of animals to be fed. Twenty percent of the cost was charged to other farm uses. Other major expenditures were for fenceline bunks and a gravel drive. Tractors were not counted as an investment in Figure 2.

Mechanical feeders can be purchased in more finely divisible units than self-unloading wagons. The investment in mechanical feeders, however, increases more rapidly with increases in the size of drove. Estimates place the cost of bunks, conveyors, meters, wiring, and other necessary parts at just under $1,000 for a 50-head drove and just over $8,000 for 800 head.

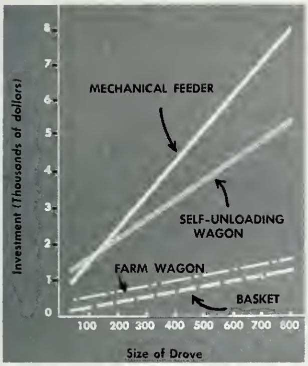
Operating Costs

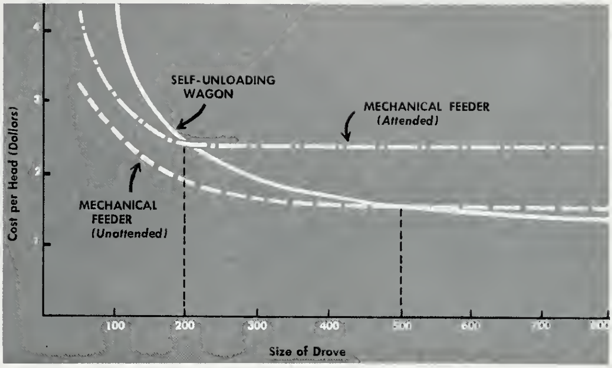
These four methods of distributing feed range from the low capital-high labor combination of basket feeding to the high capital-low labor combination of the mechanical feeder.

The cost of hand feeding approaches $4.00 per animal with droves of 50 cattle. With increases in drove size, it rises rapidly because of the greater distances to walk. Hand feeding is the least expensive method for droves smaller than 50 head. Farmers with small droves, however, may justify other methods by valuing their time above $1.00 an hour, by ignoring the overhead costs of equipment already owned, or by being willing to pay the costs to reduce drudgery.

The tractor-powered systems present somewhat of a dilemma in calculating costs. Some farmers reason that fuel is the only real cost of using their tractors in the feedlot. According to engineering tests, however, barnyard use of tractors, particularly in cold weather, results in more wear and tear than field work. Also, a tractor used with feeding equipment is often unavailable for other purposes.

Evidence suggests that a full hourly charge, including all overhead and operating costs, is the most realistic way to figure tractor





COSTS OF DIFFERENT METHODS OF FEEDING CATTLE IN DRYLOT: ***At left,*** **investment for feed bunks and distribution equipment, except tractors.** ***At right,*** **annual labor, power, and equipment costs when labor is valued at $1.00 an hour. (Figs. 2 and 3)**

use in the feedlot. When figured on this basis, the cost of feeding with an ordinary wagon is $4.00 or more per steer for all sizes of droves.

Ordinary wagon feeding does not compete with the other methods at any volume of operation. Costs for this method are therefore not included in Figure 3, which compares costs for self-unloading wagons and mechanical feeders.

As shown in Figure 3, mechanical feeders have their greatest cost advantage with droves of moderate size. With increases in cattle numbers, the costs of mechanical feeders go up more than the costs of self-unloading wagons. The fixed costs of a self-unloading wagon can be spread as thin as working time in a day will allow.

Sometimes new equipment takes the hard work out of a job, but does not free a man for other work. Most mechanical bunk feeders fall into this category at present. If the feeder must be attended, it loses its cost advantage to the self-unloading wagon when drove size exceeds 200 cattle. If the operator is free to do other chores after starting the machinery, the feeder is the less expensive method up to 500 head.

A labor value of $2.00 an hour raises all cost curves in Figure 3. This increases the advantage of the mechanical feeder, as it involves less labor than the self-unloading wagon. A higher rate of depreciation on equipment or a higher rate of interest on investment would have an opposite effect.

Making a Choice

With droves larger than 200 head, the cost differences between a mechanical feeder and self-unloading wagon are not great, particularly when labor is valued above $1.00. Owners of large droves can therefore make their choice chiefly on the basis of future plans, present situation, and personal preference.

Many farmers cannot start their cattle-feeding systems with a "clean slate," as was assumed in this study. If plans must be fitted to scattered buildings and lots, or if pasture feeding is part of the program, the self-unloading wagon has a distinct advantage. Mobile equipment may also be the more practical solution on rented farms, and its versatility can be an advantage on farms with other livestock enterprises in addition to beef cattle.

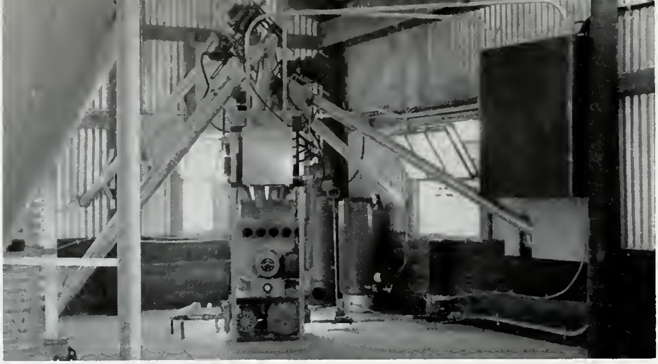
Mechanical equipment of any kind may help a farmer to get a better balance of all inputs in his farm business. Buildings, livestock equipment, labor, feedstuffs, and the other inputs of livestock production are seldom combined in just the right proportions. Labor, for example, may be fully employed while buildings are used to only 80 percent of capacity. New labor-saving equipment might therefore permit profitable expansion with little or no extra cost for housing.

Some equipment may affect the cost of other inputs. A feed mill equipped with electrical controls and metering devices, for example, requires less labor than the usual tractor-powered mill; and it may permit the use of less expensive ingredients. Even quality of the product is sometimes affected by the type of equipment.

Certainly the potential volume will be larger in a mechanized operation. This increased volume may increase total net income per man, even when mechanization does not decrease costs of production.

If mechanization offers any of these possibilities on your farm, be sure to compare the costs and advantages of the various alternatives before making your decision.

Ray Van Arsdall is an Agricultural Economist with the U. S. Department of Agriculture, cooperating with the University of Illinois. His field is the economics of farm labor, power, and machinery use. He has been here since 1949.



Feed is automatically prepared and distributed on the Warren Frye farm. Small, automatically controlled augers convey the feed ingredients from eight bulk bins to the mill. A medium-pressure pneumatic conveyor (mounted beneath the mill) transports the ground feed to any one of four discharge points. The distribution-control panel is on the wall at right; the power-control panel is on the mill.

A Complet

A FARMER who raises about 14,000 turkeys and 30,000 roasting chickens a year can save a lot of time with completely automatic feeding. Such a farmer is Warren Frye, of Peoria county. An experimental automatic feeding system was installed on his farm in June 1959, and has been in operation ever since.

The system was developed through cooperative research by the Department of Agricultural Engineering and the U. S. Department of Agriculture. Automatic equipment for processing feed was already available. What was needed was a method for conveying the material to feeding points, and also controls to keep all parts of the system working together smoothly.

Low-Volume, Medium-Pressure Pneumatic Conveyor Is Used

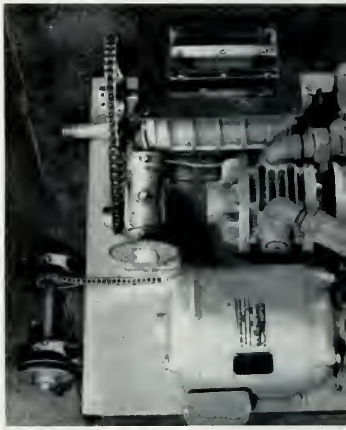
In the past, both auger conveyors and high-volume, low-pressure pneumatic conveyors have been tried for the job of distributing the feed. While both types of conveyors have possibilities, they also have definite disadvantages when used in an automatic feeding system. The chief drawback of the auger conveyor is the time lag between induction and discharge of material. Cleaning the conveyor when rations are being changed thus becomes a time-consuming job.

The main disadvantage of the high-volume, low-pressure conveyor is that it causes excessive dust at the discharge point. In addition, large sizes of pipe are needed and they must be installed with care.

Our tests have been with a low-volume, medium-pressure conveyor (here arbitrarily defined as a system that employs not more than 20 pounds of air pressure per square inch). Such a system has these advantages over a high-volume conveyor: It causes much less dust at the discharge location; it requires smaller pipe; and it produces more air pressure. As less air is moved at higher pressures, more useful work can be done with a given amount of energy.

The medium-pressure system is well-suited to automatic feed distribution for a number of other reasons: It is easy to install and control, and the feed can be routed from one loading point to any of several discharge locations. Valving and piping systems have been developed for commercial applications, and similar equipment can be used on the farm.

H. B. Puckett has been with the U. S. Department of Agriculture since 1949, and has been in Urbana since 1955, cooperating with the University of Illinois on the Chore Labor Reduction Project.



A conveyor package similar to this one is b the automatic mill. It consists of a rotary a vane-type dry air compressor, the com motor, and the drive for the airlock.

Effects of a number of variables have been studied in the laboratory. These include diameter of conveying pipe; length of system; volume of air moved; rate and direction of conveying; type of material conveyed; elbow radius; and orientation and location of elbows.

Most of the tests have been made with a rotary valve feeder. An auger feeder was tried for a while but was discarded. No satisfactory method could be devised for starting the auger feeder automatically; nor could adequate protection be provided against "blowouts."

Some of the early tests compared the conveying rates for 1½-inch and 1-inch polyethylene pipe. The maximum rate for the 1½-inch pipe was about 8,000 pounds per hour; that for the 1-inch pipe about 4,000 pounds. Since the latter rate is adequate for most feed-conveying needs, all subsequent tests were conducted with 1-inch pipe. Plastic pipe eroded too fast and control of

Automatic System for Feeding Poultry

By H. B. PUCKETT

Frye stands at the distribution-control panel, :h has a subassembly for each feeding location, one for manual control. It can serve 11 loca- s, although only four are now in use.

static electricity was difficult. It was therefore eliminated and aluminum or thin-wall steel tubing was used instead.

Tests are being conducted to determine how pressure drop is affected by conveying rate, mass of air used, and length of straight horizontal 1-inch pipe. We hope to develop a formula that will express the pressure drop in any length system within reasonable limits for conveying rate and air mass flow.

In the meanwhile, we are obtaining valuable information from two field installations: An automatic hog-feeding system, which has been operating successfully for two years; and the installation on the Frye farm.

How the Frye System Works

The system begins with bulk storage bins for eight different ingredients used to make four basic rations. These bins are automatically unloaded into the meters of an automatic electric hammermill. There the ingredients are mixed and ground. The ground material is discharged into an airlock (similar in principle to a revolving door), which places the material in the conveyor. The feed is then blown through 1-inch rigid metal conduit pipe to the discharge location. It is routed by a series of three-way pinch valves.

Two control sections are included in this system: (1) The power-control section consists of relays equipped with interlocks and safety devices to prevent improper operation of the system and protect the equipment. (2) The distribution panel controls the operation of the entire system and consists of several subassemblies.

This system is built to handle 11 feeding locations, although only four are now in use. In one hour it conveys 1,200 pounds of feed 390 feet, using 32 cubic feet of air per minute under 7¼ pounds of pressure per square inch. During the first 3 months after installation it processed and conveyed about 210 tons. It has processed as much as 6 tons in one day.

Only two major breakdowns have occurred. Both were due to a failure of the pump which furnishes most of the compressed air for the conveying system. The first failure was due to excessive pressure on the pump. The second was caused by blow-back of feed from the rotary valve into the pump at the end of a conveying period. Both of these problems have been eliminated.

There has been some tendency for the line to plug, but the causes of this difficulty have been either eliminated or minimized. Another difficulty has been the short life of the pinch valves which control the flow of feed from the main line into the branch line. At first they wore out in about a month. They now last about 3 months, thanks to some recent improvements; and further improvements are now being developed that will add still more to the expected life of the valves.

All in all, results on the Frye farm, as well as in the laboratory, show that feed distribution can be completely automatic and as convenient as piped running water.

Freshly ground feed is supplied at the feeding locations through 1-inch pipe (below). A "flap" switch in the hopper controls the distribution system (right).

MODERN METHODS of CANNING SWEET CORN

A. I. NELSON and M. P. STEINBERG

During the past 150 years, canning food has evolved from an art into a science. In 1810, when Nicolas Appert patented the process of heating food in a sealed container, he knew from 15 years of experimentation that this process would keep food from spoiling. But because he didn't know why the heating operation was effective, his process was an art. And so it remained for half a century, in spite of several advances. Only after Louis Pasteur showed that microorganisms can spoil food and that heat can destroy microorganisms did the thermal processing or heat sterilizing of canned goods become more of a science and less of an art.

From Boiling Water to Steam

Appert, using a boiling water bath to sterilize the sealed food, found that many hours of heating were necessary to safeguard the product. He also found that different foods required different processing times. A highly acid (low pH) food such as tomatoes could be taken care of in a relatively short time, but a non-acid (neutral pH) food had to be processed such a long time that it was damaged by the heat.

It was soon learned that increasing the process temperature decreased the time required for sterilization. This led to the invention of the closed retort, which allowed steam to be used under pressure and therefore at a higher temperature.

The use of steam in the retort at 240° or 250° F. became standard for processing non-acid foods. About 15 years ago, however, with stiff competition coming from frozen foods, the canning industry intensified its research on ways to improve the taste and nutritional value of canned products. The solution lay in using higher retort temperatures for shorter times.

Why Higher Temperatures and Shorter Times Are Desirable

As the retort temperature is increased above the boiling point, two things happen: The thermal death time (the time necessary to kill bacteria at any given temperature) decreases at an accelerated rate. And the amount of damage done to the food increases. Fortunately, raising the temperature a given amount does more damage to the bacteria than it does to the food. With an 18° F. increase in temperature, for example, the rate of food damage goes up about 2.5 times, while the rate of destroying bacteria is increased 10 times. Processing could thus take place in one-tenth the time with only one-quarter the damage to the product.

Agitation Shortens Process Time

In the ordinary retort containing stationary cans, temperatures above 250° F. would scorch the outside layer of most foods before the center was adequately processed. This problem in heat transfer has been solved by developing retorts in which cans are agitated while they are exposed to a temperature of about 260° F.

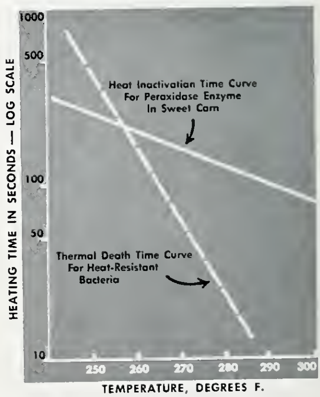
The agitation permits heat to penetrate to the center of a can much faster than in stationary retorts — provided that the contents are thin enough in consistency to be mixed by the agitation. As a result, the processing time can be greatly reduced.

Two types of agitating retorts are now used commercially. In one the cans are rolled intermittently; in the other, they are turned end-over-end. The end-over-end agitation is more positive and more effective than rolling, especially for large or institutional size containers. However, this type of retort is not well suited to a food that is easily damaged mechanically.

Would Steam Injection Give Further Improvement?

The quality of many canned foods has been improved by the relatively high temperatures and short processing times used in agitating retorts. As a result, the question has arisen as to whether still higher temperatures and shorter processing times would improve quality even more.

Recent experiments in the Department of Food Technology have been designed to help answer this question. Our experiments were with the direct injection of steam into the canned food before the can was sealed. This type of sterilization had been attempted before and several patents issued, but it had not found commercial acceptance. We wanted to develop a method that



Comparison of thermal destruction of peroxidase enzyme with that of highly heat-resistant bacteria.

could successfully be used with foods made up of separate, distinct particles such as whole kernel sweet corn.

Number 2 cans were filled with corn and steam was injected through a special device near the bottom of the can. With this equipment the individual corn kernels could be heated to 270° F. in 45 seconds. It took about 125 seconds at this temperature to sterilize the corn. Total processing time was thus less than 3 minutes. After sterilizing was completed, a sterile cover was placed on the can with sterile tongs and the lid was immediately sealed.

Some of the canned samples were examined shortly after processing and found to be of exceptionally high quality. In color, flavor, texture, and appearance, the product was similar to fresh sweet corn prepared for table use. Other canned samples were stored for 4 months at room temperature before they were opened. These samples had developed an off-flavor even though they still rated high in color and texture.

Enzyme Caused Off-Flavor

Apparently the off-flavor was caused by an enzyme, such as peroxidase. Enzymes are protein-like in nature and are necessary for practically all processes in plant and animal life.

Peroxidase is still active after the corn is harvested and is also quite heat-resistant. Severe heat treatment is therefore necessary to completely destroy it.

Apparently our experimental process for sterilizing sweet corn destroyed all the bacteria that might cause spoilage but did not completely destroy all the peroxidase enzyme. During 4 months' storage, the enzyme catalyzed certain chemical changes in the corn, which resulted in nontoxic but highly objectionable off-flavors.

These results indicated that we needed to know more about the heating time and temperatures needed to destroy peroxidase as compared with the most heat-resistant microorganisms in canned sweet

A. I. Nelson (left) came to the University as Professor of Food Processing in 1949, shortly after the Department of Food Technology was organized. M. P. Steinberg has also been here since 1949, first as a candidate for the Ph.D. degree, and now as Associate Professor of Food Engineering. Professor Nelson is standing by an end-over-end retort built especially for the laboratory; Dr. Steinberg, by a stationary retort.

corn. Experiments were therefore set up in our laboratory to study this problem.

Three types of containers were used in these studies: Capillary tubes, made of pyrex glass tubing, and about ⅛ inch in outside diameter; thermal death time cans, which are special commercial containers 2½ inches in diameter and ⅜ inch tall; and regular No. 1 commercial cans.

The capillary tubes were filled with a partially purified peroxidase enzyme extract and heated in an oil bath. Whole kernel corn was used in the other two types of container. The thermal death time cans were heated in a small stationary steam retort; and the No. 1 cans in a laboratory model end-over-end agitating retort.

In all three types of containers, it took about the same amount of time to inactivate the enzyme at any given temperature. A representative heat inactivation curve is presented on page 12. Along with it is shown a thermal death time curve for a highly heat-resistant microorganism.

It will be noted that the two lines cross and that the line representing the thermal death time of the organism is much steeper than the line representing the heat inactivation of the enzyme. At temperatures below about 250° to 260° F. the microorganism is more heat-resistant than the enzyme, but at higher temperatures the reverse is true. Therefore, high-temperature processes based on destruction of heat-resistant microorganisms may leave residual enzyme activity. This can cause serious deterioration in the quality of the canned product during storage.

Limitations Shown

It is clear from these studies that certain characteristics of the product will limit the temperature and time that can be successfully used for thermal processing. For sweet corn, the minimum processing time at about 260° F. and above should be determined on the basis of enzyme inactivation rather than destruction of the microorganisms. At temperatures of 270° to 280° F., the heat resistance of the enzyme is 10 to 20 times greater than that of the most resistant organism. Increasing the process time enough to destroy the enzyme would greatly detract from the quality — particularly the color and flavor — of the product.

It is already possible in commercial agitating retorts to process food at 260°, the approximate point at which enzymes become more heat resistant than microorganisms. The process time can also be adjusted to the safe minimum for the desired processing temperature. Reducing the time below this point might result in serious off-flavor due to enzyme activity.

At present, therefore, no real advantage can be gained by developing techniques for canning sweet corn which would involve higher temperatures and shorter processing times than are now used in our commercial agitating retorts.

Teaching Singing to the Pre-School Child

ROBERT B. SMITH

I CAN'T carry a tune in a bucket, is the oft-heard lament of many adults. Probably these poor singers, who always seem to regret their lack of ability, would be singing well today if they had received help at the right age.

All normal children are born with the capacity to become tuneful singers. But early help is crucial. According to recent studies, children who learn to sing between the ages of three and five may have a lasting advantage over those whose training is delayed until they reach school age.

Four-Year-Olds Learn to Sing

Research concerning the way children learn to sing, the type of help they need, and when they should have this help is being conducted at the University Child Development Laboratory.

One study began two years ago, with 16 four-year-olds. Each child's ability to sing was recorded at the beginning of the 1958-59 school year. Only a few were tuneful singers.

During two semesters, the 16 children met every school day for group singing training with a music specialist. From time to time, more recordings of their voices were made.

By the end of the second semester all 16 children were singing well, including those who had done poorly at the beginning. But how well would they retain this ability? This was a question we set out to answer in 1959-60.

Ability Is Retained

After leaving the Child Development Laboratory, eleven of the trained children enrolled in nine local kindergarten rooms. All the children in these nine rooms had daily experience in group singing with their kindergarten teachers. Then at the end of the first semester they received a week of training with a music specialist. They were taught unfamiliar songs, which were later used in individual voice tests.

The tests had two purposes: (1) to determine how well the eleven trained children could sing after 6 to 8 months' absence from nursery school: (2) to compare their performance with that of children who had received no musical training before kindergarten.

All eleven of the trained children were tested, as were 31 children who had not had singing help as four-year-olds, but who were similar in background to the trained group.

The tests determined the children's ability to sing well both in the lower range (from Middle C up to A) and the upper singing range (above A). All the children who had been trained in the laboratory could still sing well in the lower range. All but one sang well in the upper range. This one child was convalescing from rheumatic fever.

The 31 children who had not received pre-kindergarten training fell into several categories: Eight (25.8 percent) were very poor singers and could produce few tones with accuracy. Six (19.3 percent) could sing fairly well in the lower range but were completely unable to sing tones higher than A above Middle C. Seventeen (54.9 percent) could sing as well as the children who had received training when they were four.

This group of 31 contained most of the children who were considered by the kindergarten teachers to be their best singers. The total group of untrained children included a much higher percentage of poor singers.

It is tempting to say of the above results, "But the children who did not sing well were not born with musical talent." The children trained at the laboratory, however, were not selected because they had talent. Over 65 percent of these children had begun nursery school as very poor singers. Yet after training they all sang well.

Another comment might be: "These kindergarten children are still very young and will learn to sing well later." This may be true of some, but a head start is still a great advantage, as was shown by a related study of other four-year-olds and older children.

Robert B. Smith is now Instructor in Music, School of Music and Department of Home Economics, having come to the University as a graduate student in 1957. For two years before that he was Music Consultant for Air Force Dependents' Schools in London.

Two Age Groups Compared

The singing of a group of four-year-olds was compared with that of eight-year-old youngsters. The younger group had received three semesters of daily singing help, which began when they were three. The older group had been trained by music specialists for five semesters, beginning at the age of six.

Both groups were taught the same songs in the same way for the same length of time. The songs were more appropriate for eight-year-old children than for four-year-olds. Even so, the older children were superior only in their ability to pronounce more difficult words correctly. Several of these older youngsters sang very poorly and with limited range. As a whole, the older group tended to sing slightly below pitch. The younger children sang accurately over a wider range and had fewer vocal problems.

Summary of Findings

These studies indicate the importance of early singing. Children trained between the ages of three and five had these advantages:

They sang well after training.

They retained their singing skills after 6 to 8 months.

They performed much better than children who began singing together in kindergarten.

They sang better than eight-year-old children who had been trained since the age of six, although the older group had at least two more semesters of singing experience.

This evidence places a heavy responsibility on parents who want their children to sing well. Children need a great deal of singing experience before they start to school. Often parents or older brothers and sisters are the only ones to help them.

What You Can Do to Help Your Child Learn to Sing

Start as early as possible. Remember that the age at which most children enter the public schools is a late age for developing a tuneful and flexible singing voice. Most children will try to sing between 18 and 30 months of age if they hear others sing.

Start where the child can sing. According to research at the laboratory, most children begin to sing tones between D (first note above Middle C) and the nearest G. They need a great deal of practice within this range. Such practice can be provided with the following songs, which most parents know:

Mary Had a Little Lamb in D Major. Start on F sharp.

Old MacDonald in E Major. Start on E.

Aunt Rhodie in D Major. Start on F sharp.

Always repeat such songs in the same key. This is important for practice in matching exact tones. Check your own starting pitch with a piano or toy xylophone.

Use **recordings** to help if you have little confidence in your own singing ability. Most children who sing well when they enter the laboratory have previously sung with records.

Give the child repeated opportunities to sing songs in the lower range. The following songs provide additional practice:

Muffin Man in F Major. Start on Middle C.

Jingle Bells in D Major. Start on F sharp.

Lavender's Blue, Dilly Dilly, in C Major. Start on Middle C.

A weekly **radio program** emphasizing music for young children at home is tentatively planned for 1960-61 on WILL. This has grown out of a successful pilot program during the past year. For more information about appropriate musical materials for the home, write to the Child Development Laboratory at the University of Illinois.

Some answers about history, purpose, and organization:

THE COOPERATIVE EXTENSION SERVICE

By W. D. MURPHY

JUST WHAT is the Cooperative Extension Service in Agriculture and Home Economics? And how and why did it come into being? Such questions may have occurred to many people who are aware of some of the Extension Service's activities, but not of its history and purpose.

First of all, extension work among the people of the state is one of three distinct functions of the College of Agriculture. The other two are research and resident instruction.

The Extension Service in Illinois is part of a nation-wide system. This system is a joint undertaking of the U. S. Department of Agriculture, the land grant colleges, and the people of a community. Its operations are based on a number of laws and agreements.

The Morrill Act

The land grant colleges grew out of a campaign by Jonathan Baldwin Turner more than a century ago. A professor at Illinois College in Jacksonville, he conceived the idea of state-supported colleges that would give training in agriculture and industrial arts.

Largely as a result of his efforts, the Morrill Act was passed by Congress and signed by Abraham Lincoln in 1862. This act provided that public lands be granted to each state for the establishment of agricultural colleges. The Illinois State Legislature accepted the grant in 1867 and chose Champaign-Urbana as the site of the Illinois Industrial University, now the University of Illinois.

Smith-Lever Act

By the early 1900's, many of the land grant colleges, as well as the U. S. Department of Agriculture, were doing various kinds of extension work. In 1914, these extension activities were brought together under the Smith-Lever Act. The act included these provisions:

1. Agricultural Extension work could be continued or inaugurated in the land grant colleges.

2. Cooperative Extension work would consist of giving instruction and practical demonstrations in agriculture, home economics, and related subjects to people not attending these colleges.

3. Of the Federal funds appropriated for Extension work, 4 percent are allotted to the states by the Secretary of Agriculture on the basis of special needs; one half of the remainder is divided among the states according to the proportion that the farm population of each state bears to the national farm population; and the other half is divided on the basis of rural population.

4. Before a college receives any funds, the Secretary of Agriculture must approve a plan of work submitted by proper officials of the college.

5. College officials are required to provide a detailed statement of money received and its distribution not later than January 1 each year.

6. The college is required to give the governor of the state a full report of its Extension work, including a detailed statement of receipts and expenditures, with a copy sent to the Secretary of Agriculture.

7. The Secretary of Agriculture is authorized to make such rules and regulations as may be necessary for carrying out the provisions of the act.

In 1915 the Illinois Legislature empowered the trustees of the University to receive the money appropriated under the act and to conduct Extension work in accordance with its provisions.

The Smith-Lever Act was revised as Public Law 83 in 1953, but the essential conditions of the act remain unchanged.

Project Agreements

Through project agreements, Extension work is divided into subject matter areas. These form the basis for the primary breakdowns in making up budgets and reporting finances. The number of project agreements has grown steadily, averaging 23 a state. Illinois now has 44 agreements.

The Extension Committee on Organization and Policy, made up of Extension directors representing each of the four regions of the United States, has recommended that project agreements and other administrative documents be streamlined. Each state is now trying to combine its agreements, limiting the number to eight.

Plans of Work

Public Law 83 calls for annual plans of work for each project agreement. They describe the programs to be carried out during the fiscal year to achieve the objectives of the project agreements.

Annual Reports

Annual reports, also required by law, tell what has been accomplished during the previous year. They have become increasingly complex and time-consuming — primarily because they have been used as public relations devices, historical records, a means of evaluating a worker's effectiveness, and an aid to supervision. However, as project agreements and plans of work are simplified, annual reports will also be streamlined to emphasize the major accomplishments of the Extension Service each year.

W. D. Murphy is Assistant Director of the Extension Service.

RESEARCH IN BRIEF

How Different Conditions Affect Penta Treatment of Wood

As shown in studies by the Forestry Department, cold-soaking fence posts in an oil-solution of pentachlorophenol (penta) makes them resistant to decay and insects. Several factors, however, affect the movement of the penta into the wood. Of these, the most important seem to be temperature and viscosity of the solution, wood moisture content, and kind of treatment. Further studies have, therefore, been made of these factors to see whether better treating methods could be developed.

Basswood test blocks 1 inch by 1 inch by 6 inches were treated at four percentages of moisture: 7 (house-dry), 13, 20 (air-dry), and 28 (practically green). The blocks were soaked for 24 hours — some continuously, others intermittently. The temperatures of the penta solution were 5°, 10°, 20°, 40°, and 80° F.

Diacetone alcohol and hexylene glycol were used as solvents because they had different viscosities, did not readily evaporate, and had high solubility for penta at temperatures as low as 5° F. Although fuel oil is commonly used as a solvent for penta, it was not included in the first series of tests because it varies from one manufacturer to another and uniformity was necessary.

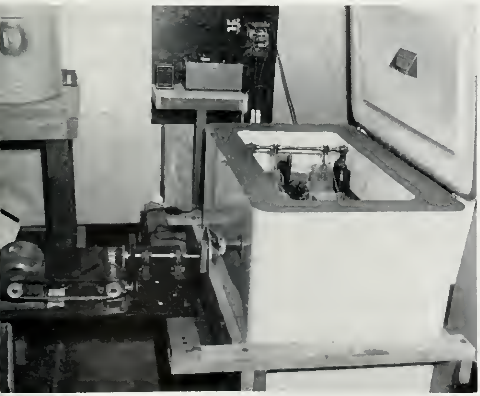
The basswood blocks were weighed before and after treatment and analyzed for chemical content to determine the amount of penta absorbed with different treatments, as well as its distribution through the wood.

Some combinations of solution temperature and wood moisture seemed to restrict liquid absorption. This was probably the result of moisture condensation in tiny openings in the wood's cell walls through which liquids usually flow. The lowest absorption was in blocks treated at 20 percent moisture content in a 40° F. solution.

Other combinations of variables improved liquid absorption. The best absorption was in blocks treated at 28 percent moisture content in an 80° solution. Wood with more than 28 percent moisture is usually too green to treat by cold-soaking in an oil-soluble chemical.

An interchange of moisture and solvent took place within the cell walls of the wood, indicating that diffusion, as well as capillarity, caused the liquid to move into the cell-wall tissue. Because the cell walls were penetrated by the penta solutions, the wood swelled. The swelling increased with the moisture content of the wood. Fuel-oil solutions, however, probably would not act in the same way because oil would not dissolve in the water held in the walls of the tiny wood cells, but would flow through the tube-like cells.

Diacetone alcohol, the less viscous or "lighter" solvent, was absorbed in greater quantities than the hexylene glycol. Intermittent treatment was not as good as constant soaking, probably because the blocks were completely submerged in the solution only 29 percent of the time. — *C. S. Walters*



This food freezer was converted into a "constant-temperature chamber" for treating basswood blocks. Treating solutions held in small tanks were kept at a constant temperature with a temperature regulator, water bath, the freezer's cooling system, and a strip heater. The electric motor operated the speed reducer and the mechanical system that dipped blocks seven times a minute for 24 hours. Other blocks were continuously soaked under the same conditions for the same length of time.

A Control for Decline of Horseradish Clones

Results from a 10-year experiment by the Department of Plant Pathology provide a remedy for the decline of horseradish clones.

A clone of horseradish is the group of individual plants that have been propagated by vegetative means from a parent plant. The clone thus consists of the parent plant plus the new plants developed from its lateral roots.

In the state's major horseradish-growing area, near East St. Louis, progenies from some plants decline when they are propagated in successive years. That is, they become less vigorous with successive generations. To avoid poor yields from weakened clones, growers obtain, from time to time, a new stock of set roots from plants grown in a northern area where decline does not occur.

The cause of decline is as yet undetermined, but appears to be associated with some general infection, probably by a virus. Since all commercial horseradish clones are infested with turnip mosaic virus, decline could result from changes in

this virus already present in the plants. Or the decline could be caused by the turnip mosaic virus in combination with one or more additional viruses.

Clones from some selected weak and vigorous plants from the East St. Louis area were perpetuated on the experimental farm near Urbana. Those from weak plants became progressively weaker as they were perpetuated, and died out in four to seven years. Those from vigorous plants, however, remained vigorous throughout the 10-year experiment. Thus, vigorous horseradish plants can be maintained and decline controlled if plants without decline are propagated vegetatively for subsequent crops. — *H. H. Thornberry*

The Sale of Plants and Flowers in Mass Market Outlets

More and more cut flowers are being shipped to the north from the south and west, where they can be grown outdoors at considerably less cost than in northern greenhouses. Potted plants, on the other hand, are bulky and expensive to ship, so it is less likely that their production will shift very far from consuming centers. It seems probable, therefore, that northern producers will turn to potted plants as a means of using facilities and meeting competition from southern and western cut flowers. Low-cost cut flowers that are adaptable to northern production methods may offer another way of meeting this competition.

The Department of Agricultural Economics has tested consumer acceptance of inexpensive potted plants and cut flowers in a supermarket, variety store, and floral shop. More "everyday" use of plants and flowers would result in increased satisfaction for the final consumers and more income for the retailers, as well as greater utilization of greenhouse facilities.

Although such products are not generally thought of as supermarket or variety store merchandise, they found high consumer acceptance in the stores where they were sold. That they competed favorably with other merchandise was shown by an analysis of average retail margins, gross returns, profits per square foot of display space, and net returns for supermarkets and variety stores.

The less expensive flowers and plants sold relatively better at the variety store, while the more expensive were more acceptable at the supermarket and floral shop. The plants and flowers used in the study were profitable items in the floral shop and increased net returns.

Among the factors affecting weekly sales, special occasions, such as Christmas and Mother's Day, had the greatest influence. Quality was also important. Sales were stimulated by introducing and reintroducing various plants and flowers, and by displaying a good selection of different kinds, varieties, and colors at the same time. Preferences as to kind, variety, and color varied with the season or special occasion. Sales rose and fell inversely with the volume of home garden production.

As the experiment progressed, indications were that an increasing quantity of flowers and plants were being used for "everyday" living.— *R. A. Kelly*

Embryo Test Not Reliable for Determining Percentage of Loose Smut Infection in Wheat

Field certification standards permit only a very small percent of loose smut in seed. Until recent years, there was no reliable technique for determining the amount of smut-infected seed until the plants had headed. This is too late to be certain that a variety will be eligible for certification.

In 1946 it was reported from Canada that barley seed having smut mycelium in either the embryo or scutellar tissue would produce a smut-infected plant. Since it was not hard to identify smut-infected seed by the embryo test, all barley must now be given the test before it receives certification in Canada.

Because the embryo test is so successful with barley, and because loose smut is a major problem in Illinois wheat production, the technique was tested on wheat. The ten varieties used for differentiating physiologic races of loose smut were included in the study. Four heads of each variety were inoculated with each of 19 races of smut. At maturity, each group of four heads was threshed, the seed thoroughly mixed, and a random sample selected for embryo examination. The rest of the seed was planted in the field to determine the percentage of smutted heads.

Embryos were examined by first soaking the seed from 12 to 15 hours in a 5-percent solution of sodium hydroxide until the embryos floated free with a slight agitation. They were then removed from the sodium hydroxide and washed three to five times in boiling water. After washing, they were placed in a nearly saturated solution of chloral hydrate containing 0.1 percent of acid fuchsin, and were heated in an Arnold steamer for one minute. They were then placed in lactophenol in a watch glass and examined under a microscope for the presence or absence of mycelium.

No general correlation was found between the numbers of infected embryos and of smutted heads. In the variety Kawvale, for example, the percentage of embryo infection ranged from 10 to 80, but not a single head of smut appeared in the field. In a few cases, the percentages of embryo infection and of smut were the same, although this was the exception rather than the rule. Some varieties inoculated with some races were infected in 100 percent of the embryos and 80 percent of the heads. There was also evidence of embryo resistance to smut, as no mycelium was observed in some varieties inoculated with some of the races, nor did any smut occur in the field.

Results of this test definitely indicate that the embryo test is not reliable for determining the percent of loose smut in wheat, and therefore cannot be used in the wheat certification program. — *W. M. Bever*

Surplus Disposal Under Public Law 480

The U. S. Agricultural and Trade Development Act of 1954 (Public Law 480) was passed to help dispose of surpluses, expand total international trade, and encourage economic development. There are four principal methods of disposal: sales for local currencies; emergency assistance; barter transactions; and long-term dollar sale contracts.

The Department of Agricultural Economics is now analyzing the effect of this law on (1) the flow of commodities between the United States and other major agricultural export countries, and (2) the agricultural imports of the hard currency countries and the countries participating in P. L. 480 programs.

Sales for the purchasing country's own currency make up the most important single means of disposal. The aim of this sales promotion is to develop new markets for American farm commodities in countries with soft currencies (currencies which are not freely convertible into dollars or gold). These countries previously did not have enough dollar reserves to buy many American products. Participation in the program is made contingent on the assurance that (1) recipient countries will continue commercial imports at their previous levels, (2) commodities acquired under the law will not be resold to third countries, and (3) the transactions will not appreciably change trade relations with other export countries.

Italy — having bought $152 million worth of farm products under this agreement — is the largest recipient among the European participating countries. The effects of P. L. 480 transactions on Italian foreign trade have been the subject of a recent pilot study.

Since P. L. 480 programs are only part of the whole trade structure, they must be analyzed in relation to all the foreign trade transactions of a country. Our pilot study indicates that national income, relative prices, cost and availability of substitutes, terms of trade, reciprocal trade, and reserves of foreign exchange have more effect on Italian foreign trade transactions than do P. L. 480 shipments.

This is not to say, however, that the effect of specific farm commodities delivered under P. L. 480 arrangements is negligible. Further study will be made of their impact upon the volume and origin of specific Italian imports.

It is hoped that once we have a better understanding of the forces shaping international demand, we will be better able to judge how well P. L. 480 is accomplishing its purpose. This knowledge should also help us to evaluate potential foreign demand for our farm products and improve our international trade policies. — *Stephen C. Schmidt*

How Starch Acts in Foods

Starch is one of the main constituents of the food we eat. Although it has attracted the attention of scientists for more than 200 years, surprisingly large gaps still exist in our information about it. We find this particularly true when we try to explain certain changes which occur during the preparation and storage of starch-containing foods.

Our present program of starch research at the University was undertaken to fill in some of the missing facts, particularly those regarding interactions between starch and other food ingredients. The mixtures studied are much simpler than those found in actual foods — just starch and water plus one or two added ingredients such as fats and emulsifying agents.

Pure fats and oils, either animal or vegetable, all lowered the temperature required for a starch-water mixture to thicken. However, emulsifying agents such as the monoglycerides found in most common shortenings had exactly the opposite effect; addition of these compounds caused higher temperatures to be required.

Just what happens to bring about this behavior is as yet an unsolved mystery. Monoglycerides and similar compounds can be made to form complexes with amylose, the straight-chain portion of starch; apparently the monoglycerides form a core around which the amylose coils itself like a spiral spring. Pure fat or oil will not do this. But how or whether this reaction with amylose is connected with the action of these compounds on the whole starch has yet to be shown.

Other food ingredients being studied for their effects on starch include various sugars and sirups, inorganic salts, and milk proteins.

It is hoped that information derived from these studies will lead us to a better understanding of the action of starch in foods and how to control it. — *Elizabeth M. Osman*

New Ways of Determining the Lean Meat in Live Animals

Radioactive potassium may provide a method for evaluating the muscularity of live animals. Experiments on this subject are being conducted by members of the Department of Animal Science, with the cooperation of Dr. Phillip Gustavson and others at the Argonne National Laboratories.

Potassium exists in the body almost exclusively in muscle tissue, with the possible exception of wool. The proportion of potassium in muscle is relatively constant at all times. In addition, a constant proportion of naturally occurring potassium is radioactive. Hence, by knowing the amount of radioactivity deriving from potassium per unit of weight, one can mathematically calculate total potassium, and hence total muscle.

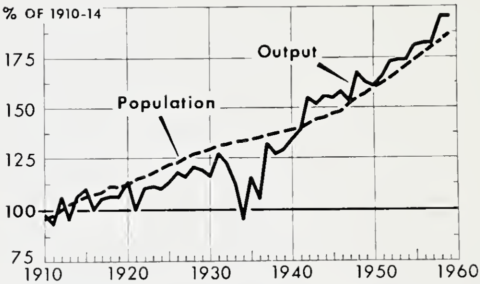
Preliminary tests on meat products of varying degrees of fatness have resulted in good agreement between naturally occurring radioactive potassium and protein content as determined chemically. Numerous difficulties must be overcome before this method can be used with live animals, but possibilities look reasonably promising at this time. — *B. C. Breidenstein*

FARM BUSINESS TRENDS

IT IS OFTEN SAID that farm output is increasing faster than our population is growing. Since the statement is frequently a basis for national policies and programs, we need to know whether it is supported by actual facts.

Getting reliable figures on population is a fairly simple matter. Not only does the Bureau of the Census count the population every 10 years, but it also makes careful estimates for other years on the basis of births, deaths, immigration, and emigration since the previous census.

Accurate estimates of total agricultural production are harder to make. One of the biggest problems is adding together into one yearly total the large variety of U. S. farm products, ranging from alfalfa to wheat, and from butter to wool. The U. S. Department of Agriculture attempts this job each year, however, and publishes the results as indexes of farm output.



Farm population and output, 1910-1959.

The chart gives the indexes of farm output from 1910 to 1959, and also the indexes of population for the same years. In calculating both sets of indexes, the years 1910-1914 were taken to equal 100. The two lines therefore start at the same level. A study of the chart shows several important facts:

1. Farm output did not increase as much as population from 1910 to the 1920's. There was no production control at the time, but most farmers were not doing much to increase yields. There was much talk about "overproduction."

2. During the 1930's farm output fell further behind population. There were some acreage restrictions, but the big dip in production from 1933 to 1936 (four years) was caused mostly by extreme drouths. Talk of "overproduction" continued.

3. Farm output jumped from 1939 to 1942, at the beginning of World War II. Acreage restrictions were dropped. Surplus corn that had been accumulated from 1937 to 1940 was converted into meat in 1942 and 1943.

4. During the 15 years from 1945 through 1959, farm production and population increased about the same. For both, the 1955-1959 average was about 18 percent greater than the 1945-1949 average.

These figures furnish very little support for the popular statement that farm production is increasing faster than population. — *L. H. Simerl*

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ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

IN THIS ISSUE

Farm woodlands are largely an unmanaged resource in Illinois (page 10). This fine stand of white oak is in Wabash county.

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ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

CONTENTS

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RESEARCH IN THE DEPARTMENT OF ANIMAL SCIENCE

includes both basic and practical studies. The major objective is a better understanding of the fundamentals of animal life. Physiological studies of various kinds are conducted involving poultry, swine, beef cattle, sheep, laboratory animals, and man.

The basic information gained from these studies has made it possible to effect economies of production and improve the quality of food and fiber. It is becoming increasingly apparent that these practical ends can be achieved only by using the fundamental tools of the physical and biological sciences. General areas of study within the department embrace biochemistry, reproductive physiology, genetics, nutrition, management, and meats technology.

More economical production has resulted from studies of amino acid requirements, vitamin and mineral metabolism, and crop utilization. Improved meat quality and better consumer acceptance have grown out of genetic and nutritional studies. A better understanding of animal reproduction, coupled with improved management practices, has done much to increase the efficiency of animal production on the farm.

Besides all these practical applications of fundamental studies, the department is also working to develop new technological concepts for immediate use by Illinois farmers.

Current investigations that look especially promising include studies of "specific pathogen free" pigs and swine housing and management studies in cooperation with other departments. — *O. Burr Ross, Head of the Department.*

Dr. Ross became Head of the Department of Animal Science in 1958, coming here from Salina, Kansas, where he was manager of the Gooch Feed Mill. Previously he had been on the staffs of the University of Tennessee, University of Wisconsin, and Oklahoma State University. A graduate of the University of Nebraska, he received his Ph.D. degree from the University of Wisconsin. During his graduate work and professional career he has done outstanding research in swine and beef cattle nutrition.

A possible peacetime use for atomic energy:

Sterilizing Food With Radiation

E. F. REBER

ONE OF THE MANY POSSIBLE peacetime uses of atomic energy is in the sterilization of food. The big question is whether such food is safe for people to eat.

In recent tests, rats and dogs ate radiation-sterilized beef for 2 years without showing any ill effects. This encourages us to believe that radiation will prove a safe method of sterilizing food.

Sterilization with radiation is often referred to as "cold sterilization" because no heat is needed. As used here, "radiation" means exposure to radiant energy. This energy is emitted from molecules and atoms as a result of internal changes.

A unit of absorbed energy is known as a "rad," which is an abbreviation for "radiation absorbed dose." A megarad is a million rads.

According to the latest data, 4.5 megarads are needed to destroy the botulism-producing bacterium, *Clostridium botulinum,* in meat. Lower dosages will kill most other organisms. Only 0.7 to 0.9 megarad, for example, will destroy the organisms causing trichinosis.

Radiation great enough to sterilize meat causes changes in odor, flavor, and texture. As a result, the radiation-sterilized product is not acceptable to some people. Changes in nutritional value also occur. All these changes, however, are independent of the wholesomeness or safety of a food.

Testing Wholesomeness

Procedures for determining the wholesomeness of radiation-sterilized beef have been suggested by the Food and Drug Administration. A ration is fed that will support growth, reproduction, and lactation independently of the beef nutrients.

Fat-soluble vitamins A, D, E, and K are administered orally 4 to 6 hours before the animals are fed. Under these conditions, any marked impairment in the health of the animals will be due to substances created by radiation.

How the Beef Was Sterilized

Several procedures may be used to sterilize with radiation. The beef fed to the rats in these studies was first frozen and then radiated with a beam of electrons from a capacitron cathode or a resonant transformer.

The beef fed to dogs was radiated with gamma rays. Source of the rays was spent fuel elements from atomic power plants. These spent elements no longer produce atomic power efficiently, but they still give off enough radiation for sterilization. They were put in a pool of water with a temperature of about 70° F. The beef in No. 10 cans was radiated by placing it in the pool.

Radiated Beef Fed to Rats

Two parent groups of rats were fed rations containing 45 percent beef solids for 2 years. One group received beef radiated with 2 megarads; the other, nonradiated raw beef.

Each group consisted of 40 males and 40 females to start with. In addition two successive generations of each parent group were fed the radiated and nonradiated beef for 30 to 35 weeks.

As shown in Figure 1, the rats fed radiated beef did not grow as rapidly or as much as the control animals. Rats on the radiated beef also produced fewer young. These differences were small, however, only a few being significant.

Average life span was significantly shorter for both sexes in the parent generation fed radiated beef (Fig. 1). Most of the deaths occurred during the last 6 months of the 2-year period. In both groups more females survived than males; and substantially more females fed the nonradiated beef survived than those fed radiated beef.

A comparison of red and white cell counts, differential count, and hemoglobin content of the blood did not indicate anything unusual for the rats fed radiated beef. It was therefore concluded that radiation did not create harmful substances and that the beef was wholesome.

The deviation in growth in the

E. F. Reber, Professor of Veterinary Physiology and Pharmacology and of Veterinary Research, weighs a dog used in the experiments. The work with dogs was done in the College of Veterinary Medicine with Drs. O. P. Malhorta, P. D. Beomer, H. W. Norton, and J. P. Kreier, under a contract with the Office of the Surgeon General. The study on rats was conducted in Swift and Company laboratories with Drs. C. E. Poling and E. E. Rice.

rats fed radiated beef seems to be due to a slight decrease in the nutritional quality of the beef. This decrease is similar to that which occurs during heat sterilization, however, and is not significant.

Radiated Beef Fed to Dogs

The dogs' ration, independent of the beef, was designed to meet the nutritional requirements of the dog as recommended by the National Research Council. The beef solids were 35 percent of the total solids in the ration.

Three groups, each consisting of two male and two female beagles, were fed. One group received nonradiated beef, while the second and third groups received beef radiated with 2.79 and 5.58 megarads respectively. Each bitch was bred twice during the 2-year study.

During the 24-week growth period, dogs fed radiated beef ate significantly less food than did the others. The decrease amounted to 1,070 grams per megarad of radiation per dog when feed consumption was statistically adjusted to assume the same initial weight for all dogs. There was, however, no significant difference in weight gained (Fig. 2) nor in food converted by the dogs.

All the males and females were fertile. Fewer pups were born to the bitches fed the beef radiated with 5.59 megarads, but there were only two bitches per group. Lactation by the females and growth of the pups were not affected by feeding radiated beef.

As with the rats, no significant difference in cell counts, differential count, or hemoglobin content of blood could be attributed to radiated beef. Nor could any consistent lesions in the tissues be associated with radiation.

The final report on this work has not been completed, but according to available results, radiated beef fed under the conditions of this experiment is wholesome.

Other Experiments

Other workers have obtained somewhat different results. On our Urbana campus, Dr. B. C. Johnson and co-workers have shown that feeding radiated beef under certain circumstances causes bleeding and death in rats. Feeding vitamin K, however, has corrected the bleeding and averted death. The left auricle of the heart has become enlarged in mice fed radiated food on the University's Chicago campus. At Cornell University and Massachusetts Institute of Technology, feeding radiated food to dogs sometimes reduced the size of litters.

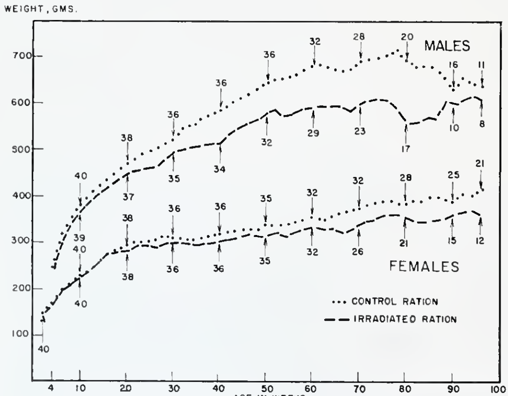
While these findings await clarification, they have been the partial cause of decreased activity in the food radiation program.

What's Ahead

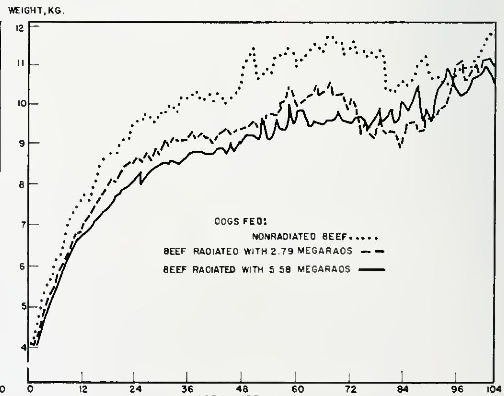
Future projects will include fundamental research on foods exposed to low levels of radiation that will pasteurize a product but not sterilize it. The purpose will be to extend the shelf life of various meats, fish, vegetables, and fruits. Selection of the particular foods to be investigated will depend on their projected future market acceptance and the technical feasibility of processing.

Radiation will no doubt introduce new flavors, odors, and other characteristics strange to the product. As a result, people may reject it at first. This has occurred, for example, with pasteurized and evaporated milk. As long as a product is wholesome, however, some people will accept it, and acceptance will grow if the new product offers advantages.

A serious limitation is the cost of processing. Until this is reduced, radiation of foods will not become important in this country. It could, however, be very valuable in underdeveloped countries, particularly where power supply is so limited that the processing methods now used in this country are impractical.



Body weights of parent rats fed nonradiated and radiated beef. Figures indicate the number of surviving animals. (Fig. 1)



Average body weights of dogs fed nonradiated beef and beef radiated with 2.79 and 5.58 megarads. (Fig. 2)

Do We Need Special Stations for Testing Dairy Sires?

A Study of Danish testing stations helps us to decide whether similar stations would be worthwhile in Illinois

R. W. TOUCHBERRY

WOULD SPECIAL STATIONS for testing the genetic differences between dairy sires be a good thing in the United States? Would they give any better results than our present methods of testing sires on the basis of their daughters' performance in farmer herds? Some people think yes, supporting their opinion with the results obtained at testing stations in Denmark.

The Danish Agricultural Research Laboratory and Danish farmers began organizing stations right after World War II. For the first testing year, which began September 1, 1945, six progeny groups were distributed among three testing stations. In 1957-58, 102 progeny groups were distributed among 33 testing stations. The smallest station had one progeny group; the largest, nine.

By studying the data from these testing stations, we can determine how well they have measured the genetic differences between sires. And this information can, in turn, help us decide whether similar stations would be advisable in the United States.

Rules Under Which Danish Stations Operate

Following are some of the regulations governing Danish testing stations. These rules are adhered to rather closely, although there are some exceptions.

1. Usually only heifers of the first year's progeny from bulls used in artificial insemination are tested.
2. Heifers must be from herds free of tuberculosis and abortus bang.
3. A test group must as far as possible comprise 20 first-calf heifers. Groups of fewer than 15 individuals are not tested.
4. The heifers must be between 27 and 33 months of age at calving.
5. The heifers are brought to the test station September 1.
6. Calving should take place between October 1 and about November 15. The heifers are bred back at the heat closest to 2½ months after calving.
7. The test lasts 10 months from the date of calving.
8. The level of feeding is alike at all stations and a little above the Danish feeding standards.
9. Feeding, weighing, and milk-testing are done or supervised by an assistant appointed by the Research Laboratory according to rules drawn up by that institution. The feed is weighed out to each animal daily and the milk is tested four times a week.

A Comparison of Station Tests and Field Tests

One way to judge the value of the testing stations is to compare tests at these stations with tests of the same sires in farmer herds. This is considered a sound criterion because the performance of a sire's daughters in farmer herds will determine his ultimate value.

Of the Red Danish Milkrace sires tested at the stations during the first 11 years, 110 also had 30 or more tested daughters in farmer herds. The daughters of each sire were distributed in 20 to 30 herds with never more than three daughters of a sire in the same herd.

By randomly dividing the 30 daughters from each sire into two groups of 15 each, it was possible to get the correlations between tests at test stations and tests in farmer herds, and also between two independent tests in farmer herds.

Differences between progeny groups kept at the same station in the same year were much larger than differences between progeny groups kept in farmer herds. Variations in environment probably caused these increased differences. Large differences, probably environmental, were also found between tests conducted at different stations in the same year, and at the same station in different years. Before the data were analyzed, the environmental differences between stations and years were removed by statistical methods. It was not possible to remove the environmental differences between progeny groups at the same station in the same year.

Environmental differences were also found between farmer herds. These were removed by expressing

R. W. Touchberry, Professor of Genetics in the Department of Dairy Science, has been on the University staff since 1948. He spent 1956-57 in Denmark on a Fulbright fellowship, collecting data for this study.

the records of the individual cows as deviations from the average of the entire herd.

Correlations between the two independent tests for each sire in farmer herds averaged 0.45 for milk production and 0.42 for butterfat production. Correlations between station and field tests averaged 0.41 and 0.44 for milk and butterfat production, respectively. According to these figures, tests in farmer herds are as good as station tests if the tests are based on about 15 daughters per sire.

Using Tests to Select Sires

A more thorough examination of the results indicates that tests in farmer herds may often be better than station tests.

Let us suppose, for example, that you are going to save and use the best two-fifths of the sires tested. How much would the yield of their future daughters be expected to exceed the yield of the future daughters of all sires tested? Would it matter whether the choice of sires was based on a test at testing stations or a test in farmer herds?

Answers to these questions are given in the table below. It shows the differences to be expected in farmer herds between the average production of the selected sires' progeny and the production of the progeny of all sires tested. In the first two columns are shown the increases in production if the best two-fifths of the sires are selected on the basis of station tests; in the last two columns, the increases if selection is based on tests in farmer herds.

Expected Superiority in Farmer Herds of Future Daughters of the Top Two-Fifths of Tested Sires as Indicated by Two Methods of Testing

No. of daughters per sire on test	Differences between progenies of top 2/5 of sires and of all tested sires			
	Progeny tested at testing stations		Progeny tested in farmer herds	
	Milk	Fat	Milk	Fat
	pounds			
5	86	3.8	81	3.2
10	101	4.3	105	4.1
15	106	4.6	117	4.6
20	110	4.8	126	4.9
30	114	4.9	136	5.3

It can be seen that for milk production, tests in farmer herds are better than station tests if the tests are based on 10 or more daughters. For butterfat production, tests in farmer herds are better when the tests are based on 15 or more daughters.

Testing Stations for Dairy Sires Rarely Justified

As we have seen from our study of the Danish results, the ranking of a sire's genetic ability was generally less accurate when based on station tests than on tests in farmer herds. Apparently the main factor limiting the accuracy of the station tests was the environmental variation that was confounded with differences between progeny groups.

Possibly station tests can be designed that will be as accurate as, or even more accurate than tests in farmer herds. It is questionable, however, whether the small possible increase in accuracy is enough to justify the costs of testing stations for dairy sires. They seem justified only when a small percentage of the cows in an area are on test and adequate tests in farmer herds aren't available; or when characteristics are being tested that are not easily measured in farmer herds.

Thus, if at least 15 percent of the cows served by an A. I. stud are on test, testing stations are not needed if only milk and butterfat production are being measured. However, relying on tests in farmer herds does put most of the burden of testing young bulls on those dairymen who are on a testing program.

When fewer than 15 percent of the cows served by a stud are on test, special stations should be seriously considered or the percentage of cows on test should be increased.

Of the cows served by Northern Illinois Breeding Co-op, more than 15 percent are on test; but of the cows served by the Southern Illinois Breeding Association, fewer than 15 percent are on test. This suggests that in southern Illinois there is a definite need either for testing stations or for more participation in Dairy Herd Improvement Associations.

Test Stations for Swine and Beef Cattle

In recent years performance testing stations for swine and beef cattle have become popular. Most of the characteristics for which swine and beef sires are tested can be measured directly on the sire himself. Such characteristics include average daily gain, feed consumed per 100 pounds of gain, and the average costs of 100 pounds of gain.

Being able to measure a characteristic on the animal being tested is a decided advantage. If the heritability of the characteristic is 0.25, it requires five daughters of the sire to estimate his breeding value as precisely as if the characteristic were measured on the sire himself. If the heritability is 0.50 or 0.75, seven and thirteen daughters, respectively, are required to obtain the same precision. Since milk and butterfat production cannot be measured directly on a dairy sire, his breeding value must be determined by a progeny test or from pedigree information.

The heritability of milk production in dairy cattle is approximately 0.25 and that of average daily gain in beef cattle approximately 0.60. Under these conditions about 23 daughters of a dairy sire would be needed to estimate his breeding value as precisely as the breeding value of a beef bull could be estimated by measuring his own rate of gain.

Beef and swine performance tests have great potential in measuring genetic differences between sires, but it is paramount that the sires on test be given an equal opportunity. One can come closer to providing this equal opportunity if the sires are at special test stations than if they are scattered in farmer herds. Thus special testing stations for beef and swine serve a real need.

Illinois Research on Penicillin in Milk

E. E. ORMISTON, J. L. ALBRIGHT, B. O. BRODIE, and L. D. WITTER

SOME SERIOUS PROBLEMS have been created by the widespread and often indiscriminate use of penicillin to treat cows with mastitis. Penicillin is used more than other antibiotics to control mastitis because it is effective against both streptococci and micrococci, the organisms responsible for most cases of the disease. The problems arise when penicillin shows up in milk that is sent to market.

Public health officials consider that such milk is adulterated and a potential health hazard. Even small concentrations of penicillin can cause reactions in highly sensitive people. To date nine cases of acute dermatitis believed to have been caused by drinking milk that contained penicillin have been reported.

Normal processing of milk does not destroy penicillin. Furthermore, penicillin causes special problems in plants making cheese and fermented dairy products, for it inhibits starter microorganisms. Most starter cultures are retarded by as little as 0.05 unit of penicillin per milliliter of milk. This means that the milk from one treated quarter of a cow could inhibit bacterial action in the milk from an entire herd.

At present, dairymen are asked to discard the milk from treated cows for a period of 72 hours after the last treatment. Recent experiments at the University of Illinois have been designed to determine whether this period is long enough to insure safe and legal milk. Cows have been given penicillin by udder infusion and intramuscular injection, and their milk has then been tested.

Udder Infusion

The udder infusions were made in 10 cows milking at various stages of their lactation period and yielding 20 to 50 pounds of milk a day. Three of the cows were infected with mastitis. The others had healthy udders as determined by bacteriological tests and clinical observations.

After a complete milking, the cows were infused in the right rear quarter at the rate of 100,000 units of procaine penicillin G. One infusion was made with the penicillin in an oil solution; and 14 days later another infusion was made with the penicillin in a water solution.

The cows were milked twice a day with a specially designed machine which milked each quarter into a separate compartment.

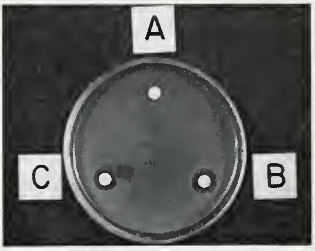
When the oil solution was used, the milk from infused quarters of half the cows had detectable quantities of penicillin for as long as 96 hours. When the water solution was used, the milk from the infused quarters of all cows was clear within 60 hours.

The penicillin was more likely to move to untreated quarters when in a water solution than in an oil solution, and it also disappeared more quickly. Regardless of the carrier, no penicillin was detected in the milk from untreated quarters after 24 hours (see table below).

Presence of Penicillin in Untreated Quarters After Infusion[a]

Cow	Oil solution	Water solution
1624	None	RF[b] and LF[b] for 12 hr.
1452	None	LF for 12 hr.
1650	RF for 12 hr.	RF for 12 hr.
1611[c]	RF for 12 hr., LF for 24 hr.	RF for 12 hr.
1620	None	RF for 12 hr.
1608	None	RF for 12 hr.
1249[c]	None	None
1487	None	RF and LF for 12 hr.
1550	LF for 24 hr.	RF for 12 hr.
1652[c]	None	None

[a] Presence of penicillin based on the Arret and Kirshbaum Food and Drug Administration test.
[b] Right front and left front quarter.
[c] Cows with mastitis.



Results of a disk assay test for penicillin in milk. White, unringed circle at "A" indicates a negative test; dark ring at "B," a positive test; and indented ring at "C," a confirmatory test.

Intramuscular Injection

The same cows were given penicillin by intramuscular injection. Procaine penicillin G in oil suspension was administered at the recommended therapeutic rates of 6,000,000 units per cow or 5,000 units per pound of body weight. Penicillin was not detected in any of the milk after this treatment.

A more sensitive test would probably have shown traces of penicillin after intramuscular injections. And it might also have shown penicillin persisting longer after udder infusions. However, the test used in this study is the one approved by the Food and Drug Administration and used by regulatory officials.

72 Hours Usually Adequate

According to the results of this study, as well as those reported by other investigators, the requirement that milk from treated cows be withheld from the market for 72 hours is generally adequate. However, the milk from quarters infused with penicillin G in oil suspension should be withheld for as long as 96 hours.

Milk from non-infused quarters or from healthy quarters of cows treated intramuscularly can be used for calf feeding. It should be withheld from the market to comply with current regulations.

E. E. Ormiston is Associate Professor and J. L. Albright, Assistant Professor of Dairy Husbandry; B. O. Brodie is Assistant Professor of Veterinary Clinical Medicine; and L. D. Witter, Assistant Professor of Food Microbiology.

How Many Calories Does a Woman Need?

Studies in Department of Home Economics indicate that present allowances for middle-aged women may be too high

BEULA V. McKEY, JULIA O. HOLMES, and CAROL W. GESELL

MIDDLE-AGED WOMEN may not need as many calories as present-day standards indicate. This tentative conclusion is based on studies in the Department of Home Economics.

The calorie requirements of three women — whom we'll refer to as "B," "C," and "D" — have been investigated. "B" was 51 years old; "C," 61; and "D," 41. These women were on the Home Economics staff. All were active and healthy.

For the tests, they were requested to arrive at the testing center at 7 o'clock in the morning, after having complied with these requirements: They must have consumed no food or liquid during the preceding 12 hours. They must have spent at least 8 hours in sleep or complete relaxation the night before the test. And they must have engaged in the minimum of physical activity while dressing and getting to the testing center. (These specifications are used throughout the world in studies of calorie expenditures.)

Basal Metabolism Tests

After arriving at the laboratory, each woman removed her shoes and all tight-fitting clothing that might prevent relaxation, and lay on her back on a comfortable bed. She was instructed to remain quiet, without moving her body, during a 60-minute rest period and during the test periods that followed.

After the 60-minute rest period, a mask was fitted tightly to her face. The mask had two openings. Flutter valves allowed fresh air to be drawn in through one opening and expired air to be expelled through another. The expired air was carried through a tube to a steel cylinder, where it was collected. After a 6-minute collection period, the volume of expired air was measured and samples were analyzed for oxygen and carbon dioxide. Calories used by the women as they lay completely relaxed were determined from these analyses. The calorie expenditure under these conditions is referred to as the basal expenditure or the basal metabolism.

The basal caloric expenditures, expressed on a 24-hour basis, were 1,074, 1,067, and 1,222, for "B," "C," and "D," respectively. These were 24 percent, 25 percent, and 13 percent *below* the "standard values" that Aub and DuBois obtained 30 to 40 years ago on a large number of women subjects.

The basal metabolic rate for "D," deviating less than 15 percent from the average, would be considered a low-normal by most physicians; the values for the other two women would be judged extremely low. Basal metabolic rates this low are often caused by abnormally low activity of the thyroid gland. None of these women, however, had any physical signs of a sluggish thyroid, such as coarse, dry, brittle hair or thick, puffy skin. Hence they must be considered normal.

A likely explanation for the low basal calorie expenditures of "B" and "C" is their age — they were 10 and 20 years older, respectively, than "D." Basal metabolism rates are expected to decline with increasing age. According to the standards for women established at the Mayo Foundation, calorie expenditure will normally drop precipitately from the very high level characteristic of early childhood to a level about 30 percent lower at age 25. The rate continues at this level throughout the rest of the reproductive period; at the menopause it starts another slow decrease, which lasts until about the age of 63. By this time calorie expenditures are 40 percent lower than in early childhood.

Even though the Mayo Foundation standards take into account these decreases, the calorie expenditures of "B" and "C" were about 17 percent lower than the Mayo standards. The question arises as to whether other women of this age would expend as few calories if they were studied under the same carefully controlled conditions that characterized this Home Economics study. Obviously the basal metabolism of many more women in this age range should be studied.

Sitting Tests

Other tests were made while the women sat relaxed in comfortable chairs, with hands folded in their laps and feet elevated to a comfortable height. "B" used an average of 13 percent more calories than while lying down; "C," 5 percent; and "D," 11 percent. When these values were calculated on a 24-hour basis, the women needed 140, 53, and 134 more calories for sitting than for reclining.

But these women were in a sitting position for only about 12 hours a day. This, of course, would cut the above caloric requirements in half. "B," "C," and "D" would require only about 70, 27, and 67 more calories a day, respectively, when sitting relaxed than when lying down.

Actually, the requirements for a 12-hour sitting day would be somewhat more, for while sitting the women would often be engaged in such activities as working at their desks, driving long distances to meetings, eating, and playing cards.

Two of the authors are shown with the equipment for collecting expired air — the first step in determining energy expenditure. Beula V. McKey, Assistant Professor of Nutrition, stands by the gasometer, where the expired air is collected and measured. Carol W. Gesell, former research assistant, is taking the sitting test. Co-author Julia O. Holmes is Professor of Nutrition.

The muscular movements involved in such activities would require more calories than were expended during the sitting test. At other times, the muscles, though not flexed, would be under greater tension than during relaxed sitting. Although these muscle movements and tension would increase the expenditure of calories, the increase would not be very great.

Standing Tests

A third series of tests measured caloric expenditures while standing. The women were required to place their feet far enough apart that they could shift their weight from foot to foot as people normally do when they stand talking or working at tasks, such as washing dishes, which confine them to one spot.

During these tests, "B," "C," and "D" expended 22, 8, and 5 percent more calories than they did during the reclining tests. These increases amounted to only 20, 7, and 5 calories when calculated on the basis of a 2-hour standing day. This is the approximate length of time that the women stood in a relatively motionless position—for example, while lecturing, talking to friends, or standing in line at the cafeteria. The extra calories required for the 2 hours of standing could be supplied by as little as ⅓ to 1¼ teaspoons of sugar a day.

Total Calorie Requirements

The women spent 20 to 22 hours of their day in sleeping, sitting, or standing. The rest of the time they were engaged in such activities as walking from room to room at home and office, preparing meals, tidying living quarters, bathing, and dressing. These activities would take more calories than standing for similar periods of time, but the difference probably was not great. None of the women engaged in brisk or strenuous exercise such as swimming, dancing, or tennis, and none walked from home to office. In fact, they would all be termed sedentary. It is, therefore, possible to predict, within 100 calories or so, their total 24-hour caloric requirements.

"B," whose 24-hour basal calorie expenditure was 1,074, needed 70 extra calories for 12 hours of sitting and 20 for 2 hours of standing, the total adding up to 1,164. On adding an estimated 100 calories for the other 2 to 4 hours unaccounted for, a daily calorie requirement of 1,264 would be obtained for her. By the same method of calculation, "C" would require a total of about 1,200 calories; and "D," 1,394. These are very low requirements indeed.

The Food and Nutrition Board of the National Research Council suggests much higher daily caloric allowances — for example, 2,200 for women 45 years old and weighing 128 pounds; and 1,800 for 65-year-old women of the same weight.

These allowances are for women who are neither sedentary nor engaged in hard physical labor. They might, for example, be homemakers, store clerks, or factory workers. Although they would thus be more active than the women in the Home Economics study, their extra calorie consumption would not be great enough to account for the differences in the figures. All this emphasizes the need for more studies on women between 40 and 65.

The three women in this study would gain weight if they consumed more calories than their estimated 24-hour needs. How much they would gain can be determined by the estimated number of calories — namely, 3,500 — that are stored in 1 pound of body fat. On this basis, a person who ate, every day for a year, one teaspoon of sugar (or a half teaspoon of fat) in excess of his needs would gain 1.7 pounds a year or 17 pounds a decade. After 25 years he — or she — would not only be overweight but would be classed as obese.

Most people will need to rely on their scales to tell them if they are exceeding their calorie needs. According to the Food and Nutrition Board, ". . . the proper calorie allowance for an individual is that which over an extended period will maintain body weight . . . at a level most conducive to well being."

Research needed to make

ILLINOIS WOODLANDS AN ECONOMIC ASSET

I. IRVING HOLLAND

ILLINOIS FARMERS, as a group, are not taking full advantage of one of their resources — more than 3 million acres of forest land.

Altogether Illinois has 3,938,000 acres of woodland. All but 5 percent of it is privately owned. Of the woodland owners, 89 percent or about 116,500 are farmers, controlling about 82 percent of the state's total woodland acreage. Most of the individual holdings are smaller than 100 acres.

Practically all the timber volume of Illinois is in hardwood trees, adding up to 11.6 billion board feet. Of this, 88 percent is in sawtimber stands.

Annual net growth in Illinois amounts to about 135 million cubic feet, including nearly 500 million board feet. Annual cut, however, amounts to only about 40 million cubic feet, including about 110 million board feet.

At the same time, Illinois wood-using industries, which need about 2 billion board feet a year, are importing 90 to 95 percent of this requirement. Of the wood used, about three-fourths is softwood and has to be shipped in. However, there is still a big potential market in this state for native hardwood.

Obviously, if the timber growth from our Illinois farms can be profitably channeled to the state's wood-using industries, both farmers and manufacturers will benefit.

This is particularly important when incomes from agricultural crops are falling and costs are rising. It is quite possible that forestry can be a profitable alternative investment, particularly where some surplus farm labor is available part of the year or where land may not be well suited to field crops.

Attention to forest management now can pay off in the future. By 1975 Americans will probably be using about twice as much wood as they are today. If Illinois farmers plan ahead now, they can supply a significant part of the expanded requirement of the state's wood-using industries. Otherwise the industries will step up their imports, and forest owners, processors, and marketers in Illinois will not share adequately in the growth of the forest economy.

In recent years we have learned a great deal about the physical and biological aspects of forestry management. What we need now is economic information to supplement this knowledge.

Over-All Plan Valuable

Before starting any research projects, we first need to (1) define the subject-matter areas where fruitful research can be conducted; (2) assign priorities to these general areas if possible; and (3) specify the types of projects to be developed within each area. This "view from above" is more apt to result in better organized research aimed at achieving specific objectives than is a "view from below," where it is hoped that the completion of enough projects will result in the attainment of some goal.

Often, through lack of funds, it is impossible to carry out exactly a preconceived line of research. Still, such a plan can serve as a useful guide and point of reference; and

A Department of Forestry staff member found this cottonwood veneer box along the St. Lawrence river in Quebec last summer. Made in southern Illinois, it had been used for the military export of meat. Illinois wood-using industries can provide farmers with an expanding market for their timber.

projects developed outside the plan can be evaluated in the light of major objectives.

The following discussion does not describe a complete program of research in forestry economics for Illinois. It nevertheless indicates the type of work that the Department of Forestry hopes to undertake in developing the assets represented by our Illinois woodlands.

Objectives of Research

The over-all goal of our program is to answer these questions: What economic deterrents to good management are now decreasing income from the forest resource? What economic incentives will increase this income?

Of more immediate concern are three closely related secondary objectives, whose attainment would largely fulfill the over-all objective:

1. *Increased woodland management,* especially on farms, where such management will increase returns to the owners. Sooner or later noncommercial values which benefit society in general must also be considered. These include recreation and the protection of wildlife and watersheds.

2. *More efficient marketing procedures,* which would increase the returns both to agents marketing

forest products and to the owners of the forest resource. The public would also benefit through lower costs.

3. The solution of technological and economic problems that now limit the use of native hardwoods in the state's largest secondary wood-using industries. (These include manufacturers of furniture, barrels, boxes, and similar products.)

Priorities

To meet the goals defined above, investigation is needed in at least three general areas: (1) economics of forest management and timber production; (2) marketing of primary forest products (including logs, bolts, pulpwood, lumber, and other products of the sawmill); and (3) marketing of forest products in secondary markets.

These areas are so closely related that assigning priorities isn't easy. However, with the dearth of basic economic information about timber management, work should probably be begun in this area first. Marketing research should be initiated as soon after as possible.

A Suggested Research Program

In forest management and timber production. We have some data on number, kinds, and size of forest holdings, and volume and growth of the state's timber resource. However, we have no information on the characteristics of owners, their attitudes toward forest management, their response to existing or potential programs of forestry assistance, and related topics. Such information is basic to all studies aimed at discovering why management is not more widespread and intensive on small woodland holdings.

Of equal importance is the need for economic analyses of forest management alternatives in general, and of forestry-farming alternatives in particular. These studies could yield some answers to the frequently asked questions, "Will forestry pay on my land?" and "How can I best combine my farm resources, including the timber resource, to increase my farm income?"

Much of the needed basic data could be obtained through the following projects:

1. Characteristics of forest land holdings and forest owners in Illinois as related to present and potential forest management. (A project in this area has been begun.)

2. Economic evaluation of increased forest management on Illinois forests.

3. Economic alternatives in the management of farm woodlands in Illinois.

Marketing of primary forest products. Again there is a need for basic data first of all. Such data would include descriptive information on the extent, importance, location, and general character of marketing systems for primary forest products in Illinois. This background information, which could be obtained through a survey-type study, would be the basis for planning further research in marketing.

Just as important is the need for research on the structure and functioning of marketing systems. Research of this type must be carried on in some depth. First we have to learn in detail how a particular marketing system works. Then we can evaluate its performance in view of how it might work. This way major problems and inequities may be brought to light. Ordinarily such research is best handled on a regional basis because forest products markets are not often confined to single states.

Basic data could be obtained through the following projects:

1. Timber products marketing in Illinois. Since July 1 the Department of Forestry has been working on this project as a contribution to a North Central regional marketing study of forest products.

2. Feasibility of expanding the hardwood pulpwood market in Illinois.

3. Economics of processing and marketing primary forest products (by specific product).

Marketing forest products in secondary wood-using industries. Manufacturers of wooden products in Illinois import about 90 percent of the wood they need, even though the state's annual net saw-timber growth is about 390 million board feet greater than the volume cut. The reasons for this disparity are complex and not yet well understood.

Very little research has been done on the size, location, and importance of the several secondary wood-using industries in Illinois. There have been no studies on the kinds, volumes, and specifications of wood used. Research on these topics could indicate what must be done in the processing and marketing of the state's primary forest products if secondary markets are to expand.

A suggested beginning project in this area might be entitled "Secondary Markets for Wood in Illinois." This could be followed by studies designed to solve the technological and economic problems involved in developing the markets for particular forest products.

The Gains From Economic Research

As was said at the beginning, we know quite a bit about the physical potential of forest lands in Illinois. A number of production and marketing programs now appear possible from a physical point of view. Our economic studies would indicate which programs also appear promising in actual practice and which ones do not.

If farm woodlot owners adopt the programs that do seem economically promising, much can be done to improve forest management and marketing practices in Illinois.

I. Irving Holland, Associate Professor of Forest Economics, came to the University in 1959 from Iowa State University. He did both his undergraduate and his graduate work at the University of California.

Searching for reasons why
SOME POPCORN DOESN'T POP WELL

W. A. HUELSEN

W. A. Huelsen, Professor of Vegetable Crops, *Emeritus*, with the machine used to measure popping expansion. Professor Huelsen retired September 1 after 39 years with the University. In addition to his research on popcorn, he has done a great deal of work on breeding sweet corn, lima beans, and tomatoes. Over 25 percent of all sweet corn grown in this country is from his inbreds. A lima bean and a tomato that he developed have won the All American silver medal. He has written a standard reference text on sweet corn and many other publications.

"Why doesn't my popcorn pop better?" is a question that shows up in many letters received by the Department of Horticulture every fall and winter.

Poor popping may, of course, be due to disease. If plants have been severely attacked by bacterial wilt, for example, popping may be inhibited almost completely. In most such cases the kernels show visible signs of damage.

Usually, however, the samples accompanying the letters appear normal in every way. Seemingly the only reasons why they might pop poorly are that they contain either too much or too little moisture.

All samples are given certain routine tests in the laboratory, including an oven moisture test which takes 7 days. If the sample is too dry, water is added to bring the moisture content to 12.5 percent, which is considered most desirable for maximum expansion. The sample is then placed in a jar, sealed, shaken once a day for 3 days, and held for a total of 2 weeks so that the added moisture can spread evenly through the kernels. After that the sample is given two popping tests. If the sample is too moist to start with, it is dried to the proper moisture content before popping.

Despite these precautions, popping failures occur. A common type of failure is low popping expansion. To be commercially acceptable, one volume of raw popcorn must expand to 30 or more volumes when popped. Many properly conditioned lots will expand to 38 volumes. Some lots sent to the laboratory for testing have expanded to only 10 volumes.

Failures may also consist of varying percentages of partially popped kernels or of completely unpopped kernels. Combinations of both types of failure are common.

Problems Studied in Field Experiments

The cause of sub-standard popping has been the subject of experiments since 1951. (Reports of the first experiments have been published in Illinois Bulletins 616 and 625.)

The most recent study has been a 3-year unpublished field experiment on the relation between artificial injuries to the growing plant and the development and popping of kernels. This project is an excellent example of the trial and error type of experiment in which it is only possible to give a reasonable guess concerning the cause of the trouble.

It may as well be admitted at the start that no solution of the problem has yet been found. One difficulty is that nobody even knows why popcorn pops and other types of corn do not. One theory is that the structure of the starch granule is such that if it contains the right amount of moisture it will explode when enough heat is applied. The starch granules of the endosperm must be surrounded by the uninjured hull (pericarp) to obtain the maximum expansion in volume. Damaging the hull will reduce popping expansion and removing it will inhibit popping almost entirely.

Despite the lack of positive results, the work should be of interest because a number of possible causes have been eliminated.

Frost Damage

Growers often attribute popping failures to frost damage, but this could not be confirmed experimentally.

In one experiment, two hybrids — Iopop 6 and Purdue 202 — were harvested at four different times. Moisture contents at harvest ranged from 27.8 to 20.2 percent for Iopop 6, and from 28.3 to 13.7 percent for Purdue 202.

The husked ears were frozen for 24 hours at +25°F. and −40°F. and then dried at room temperature. No consistent impairment was noted in any of the corn.

In other tests popcorn was harvested weekly from October 3 to as late as December 26. Again there was no reduction in popping even in

corn that had been exposed to severe winter weather.

Stage of Maturity

It is generally believed that maximum popping expansion is obtained when the corn is properly matured in the field. If this were true, then corn harvested too early would have a low expansion. In one series of experiments, however, corn popped normally after being harvested with a 35 percent kernel moisture content and dried artificially.

Injuries

The preceding experiments led to the conclusion that something happened to the plant in the field which in turn kept the kernel from developing normally. Weather conditions such as drouth, excessive rainfall, and temperature were eliminated on the basis of inspection.

A new set of experiments was then devised. These consisted of periodically injuring the growing plants in various ways as they developed. Tests with field corn at several experiment stations had shown that such injuries would reduce yields.

These new field experiments were run for 3 years (1957-1959). Plants were injured in seven different ways. In 1959 the injury tests were varied by bringing in another factor — soil fertility. The plots were replicated 3 to 5 times and accurate records were kept of moisture content, yield, and popping expansion.

Two of the more severe treatments were complete defoliation and "topping," or cutting off the stalk a few inches above the upper ear shoot. Early defoliation completely prevented normal kernel development (Table 1). Even when delayed until 28 days after mid-silk, defoliation greatly reduced yields. In spite of low yields and poor kernel development, however, popping expansion was nearly as good as in the control.

In 1958 topping caused a similar reduction in yield (Table 1), but the effect on popping expansion was negligible.

The topping series, as well as other mutilations, was repeated in 1959 (Table 2). One series was grown on soil low in fertility and a second on soil of average fertility. The 1959 growing season at Urbana was extremely dry and the corn wilted badly, especially on the low-fertility soil.

All the yields on the poor soil were low. Except for plants topped 28 days after mid-silk, the topped plants yielded less than the control plants. Most of the topped plants on the more fertile soil yielded about the same as the controls. Allowing for slight errors in popping, none of the mutilations had any noticeable effect on popping expansion.

Kernels from plants which had been mutilated at mid-silk, or shortly thereafter, were smaller and not as well developed as those from the adjacent controls, but as mentioned above, popping did not suffer.

Six years of experimental work have eliminated a number of environmental factors which do *not* affect popping. However, the reason why many normal-appearing lots fail to pop satisfactorily still remains elusive.

ILLINOIS is an important producer of popcorn, ranking third among the states (after Indiana and Iowa) with a production of 40 to 65 million pounds. Most of the commercial acreage is in the southeastern part of the state. Popcorn is also a favorite in the home garden, and most requests for information received by the Station come from amateur growers.

Popcorn may be grown in the same way as field corn, but certain precautions are needed. If sweet corn and popcorn are grown close together, they will cross. The sweet corn will acquire a starchy, though not unpleasant, flavor. The popping expansion of popcorn, however, will not be impaired. Crossing popcorn with dent corn pollen will seriously impair popping, but will not harm the dent corn. Crossed seed should not be saved.

Table 1. — Shelled Yield, Bone Dry Basis, and Popping Volume of Purdue 202 Popcorn When Mutilated in Various Ways (Averages of Five Replications, 1958)

When treated	Complete defoliation		Adjacent normal control		Top removed		Adjacent normal control	
	Lb. per acre	Popping volume	Lb. per acre	Popping volume	Lb. per acre	Popping volume	Lb. per acre	Popping volume
At mid-silk	none	....	.....	....	1,765	38.6	2,223	39.8
7 days later	none	....	.....	....	1,829	38.6	2,138	39.2
14 days later	493	34.6	2,126	38.1	1,874	38.8	2,182	39.5
21 days later	1,139	36.7	1,954	38.1	1,777	38.9	2,166	39.4
28 days later	1,665	37.7	1,946	39.1	1,982	38.4	1,998	38.6

Table 2. — Shelled Yield, Bone Dry Basis, and Popping Volume of Topped Iopop 6 Popcorn Grown on Soils of Two Fertility Levels, 1959

When treated	On low-fertility soil				On good-fertility soil			
	Top removed		Adjacent normal control		Top removed		Adjacent normal control	
	Lb. per acre	Popping volume	Lb. per acre	Popping volume	Lb. per acre	Popping volume	Lb. per acre	Popping volume
At mid-silk	1,103	36.6	1,204	38.0	2,006	37.4	2,327	37.8
7 days later	1,184	37.6	1,304	37.6	2,146	37.0	2,187	36.6
14 days later	1,224	38.3	1,424	37.8	2,063	36.6	2,146	37.8
21 days later	943	37.8	1,304	38.3	2.407	37.0	2,327	37.2
28 days later	1,284	37.2	1,184	35.3	2,287	37.4	2,046	36.3

Liquid Fertilizers as Good as Dry Ones

A. L. LANG and C. K. MARTIN

LIQUID SOLUBLE FERTILIZERS are becoming increasingly popular in Illinois. The most common ones contain only nitrogen; or nitrogen and phosphorus; or nitrogen, phosphorus, and potassium.

That their use is justified is indicated by University of Illinois experiments. For two years in a row liquid fertilizers have increased corn yields as much as dry fertilizers.

In 1958 tests were conducted at Elwood and at two locations in Urbana (the Agronomy South Farm and the Agricultural Engineering Farm). The following year, tests were conducted at Elwood and Mahomet. The soil type at Elwood was Symerton silt loam; at Urbana, Drummer silty clay loam; and at Mahomet, a Catlin-like silt loam.

Plan of Experiments

In 1958 a 12-6-6 grade of liquid fertilizer was compared with the same grade of a dry mixture (see Illinois Research, Spring, 1959, page 17). Both fertilizers were broadcast and plowed down ahead of corn at rates of 800 and 1,600 pounds an acre. Half of each plot also received an 8-16-0 mix, in both liquid and dry forms, as a starter. It was banded to one side of the seed at planting time, the rate being 100 pounds an acre. These various treatments were tried with both 12,000 and 16,000 plants an acre at each location.

The following changes were made in 1959: A 15-5-5 grade of fertilizer was broadcast and disked in ahead of planting. Rates were 600 and 1,200 pounds an acre. The banded grade of fertilizer was 6-18-6, applied at rates of 100 and 300 pounds an acre. It was used on plots that had no previous broadcast application, as well as on the plots that had received the 15-5-5 fertilizer broadcast. Population rates were raised to 16,000 and 22,000 plants an acre.

A. L. Lang is Professor of Soil Fertility and C. K. Martin is Assistant in Agronomy.

Effects of Fertilizer

Regardless of the form of fertilizer, if enough plant nutrients were added to meet soil test requirements, yields were markedly increased (see table). Average increase for all experiments was 17½ bushels an acre. Liquid mixes produced a 19-bushel increase; and dry mixes, a 16-bushel increase. The 3-bushel increase in favor of the liquids was not, however, statistically significant.

In the early part of both seasons, corn receiving starter fertilizer grew markedly better than that receiving just the broadcast fertilizer. This initial growth, however, did not significantly increase yields. The amount of early growth was about the same for the liquid form of the starter fertilizer as for the dry form.

Population Rates

In 1958, acre yields were 12 bushels higher on plots with a population of 16,000 plants an acre than on plots with a 12,000 population. This was an average increase for all three locations and was not related to rates, kinds, or placement of fertilizer.

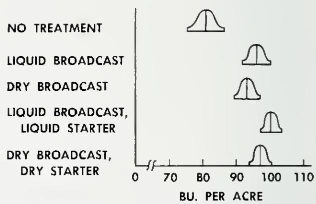
Average Corn Yields All Locations, All Populations

Treatment	Bushels of corn per acre		
	1958	1959	Aver.
No treatment	92	70	81
Liquid broadcast	112	80	96
Dry broadcast	110	76	93
Liquid starter	...	78	..
Dry starter	...	77	..
Liquid broadcast, liquid starter	112	89	100
Dry broadcast, dry starter	112	82	97
Liquid broadcast, dry starter	113	..	..
Dry broadcast, liquid starter	108	..	..

In 1959, plots with 22,000 plants per acre yielded no better than those with 16,000 plants. This was probably because yields were generally lower and 16,000 plants per acre were near maximum for top production that season. The higher population plots were severely lodged at Elwood, causing some loss of corn and a slight reduction in yield.

A Matter of Individual Choice

From the results obtained with liquid fertilizers, one can say that they offer another source of plant nutrients. They seem to be just as good as, but no better than other sources. Whether they should be used or not depends on how well they fit an individual's needs, on the convenience of handling and applying, and on the price per unit of plant nutrients.



Averaging a large number of data gives us a measure of variability due to factors beyond our control. Vertical lines here show, for each treatment, the average of all replications, fertilizer rates, populations, and locations in both years of our study. Expected variability is shown by the curves (known as frequency distribution curves). On the basis of our results, we expect averages from similar treatments and conditions to fall somewhere under their appropriate curves 95 percent of the time; most averages would be in or near the center. If curves overlap (like those for the treated plots), differences between treatments are not statistically significant. Differences between untreated plots and treated ones are significant, however, since the curve for the untreated plots does not overlap the others.

Equipment used to measure ammonia losses during tillage.

To cut costs, apply ammonia as you till the soil

B. J. BUTLER

LOOKING FOR WAYS to cut crop production costs? One excellent way may be to apply anhydrous ammonia and till the soil in one operation.

Separate application of ammonia usually costs 2 dollars an acre or more and calls for farm labor when it is sorely needed in other field operations. The extra trip across the field to apply ammonia also increases soil compaction.

Losses Low in Field Studies

Very little ammonia is lost if it is properly applied during plowing and disking. This has been brought out during the past 2 years in field studies by the Department of Agricultural Engineering. The tests were conducted on three soil types and under widely varying conditions of soil moisture and temperature.

The ammonia was applied under the furrow slice of a moldboard plow or behind the rear gangs of wheel-mounted tandem disk harrows. In all tests the ammonia was released at points almost as deep as the tillage so that a maximum of loose soil was above the escaping fluid. Application rates varied with the speed of tillage but were from 140 to 200 pounds per acre on the basis of 40-inch spacing.

Samples of the escaping ammonia were trapped in inverted pans and pumped through a weak boric acid solution which absorbed the ammonia. To find the amount absorbed, a current was passed through the solution and the drop in electrical resistance measured. The lower the resistance, the greater the amount of ammonia present. The amounts absorbed were then converted mathematically to the percentage losses occurring.

Average losses obtained from more than 50 tests of plow and disk application are compared in the table with losses from conventional knife application. All losses are very low, although those with the knife application are the lowest.

Amount of Ammonia Lost

Type of application	Rate[a] (lb./A.)	Depth (in.)	Av. losses (pct.)
Moldboard plow	140-170	3	1.04
		6	.35
		9	.15
Wheel-mounted tandem disk	150-200	4	.114
		5	.01
Knife-type applicator	115-145	5	.01
		8	.005

[a] On the basis of 40-inch spacing.

The highest loss figure of 1.04 percent at the very shallow plowing depth of 3 inches represents a nitrogen loss of only about 10 cents an acre at current prices.

Studies of the amount of ammonia diffusion in the soil showed that spacings as close as 8 inches could be used. With the 8-inch spacing and the same rate of ammonia release used in these tests, rates as high as 750 pounds per acre should not increase the percentage losses.

Visible Losses

However anhydrous ammonia is applied, uneven ground, extreme cloddiness, excess trash, and other unusual conditions can increase losses, even causing visible or "smoking" losses. Visible losses did not occur where the soil was friable and left well-leveled after tillage.

In the tests just reported, visible losses were not measured. Studies of the amount of loss occurring with various degrees of visible loss are now underway. Preliminary results indicate that "smoking" is likely to represent a considerable loss of ammonia. Losses have always been very low where smoking did not occur.

How to Keep Losses Low

Research to date has shown that ammonia can be applied during tillage with very low losses. A good job of tillage must be done, however, and the ammonia released under a fairly loose soil. If visible losses occur, they can be decreased by leveling the soil behind the plow or disk, dragging loose soil over the line of release, or using deeper tillage with deeper ammonia placement.

Any tillage tool permitting ammonia release at a depth of more than 4 inches with loose soil above that depth can probably be used to apply anhydrous ammonia. Such implements would include moldboard and disk plows, several types of disk harrows, spring-tooth harrows, field cultivators, and subsoilers.

B. J. Butler is Assistant Professor of Agricultural Engineering.

Breeding OAT VARIETIES Resistant to YELLOW DWARF

C. M. BROWN and H. JEDLINSKI

LAST YEAR Illinois farmers lost almost $25,000,000 worth of oats as a result of *yellow dwarf*, or *red leaf*.

This devastating and widespread disease also attacks wheat, barley, and many cultivated and wild grasses. As a matter of fact, the virus responsible for the disease is called *Barley Yellow Dwarf Virus* (BYD) because it was first discovered causing yellowing and dwarfing of barley in California.

Six different species of aphids carry the virus from diseased to healthy plants. As far as we know, the virus is neither seed- nor soil-borne.

A Quarter of the Oats Crop Gone

Yellow dwarf, together with the greenbug (aphid vector) feeding damage associated with the disease, caused an estimated loss of 34,349,000 bushels of oats in Illinois in 1959. This represents 28 percent of the estimated potential crop production. On the basis of the December 15, 1959, oat price of 71 cents per bushel, the loss cost Illinois farmers about $24,388,000.

H. Jedlinski (left) is Pathologist, Crops Research Division, U. S. Department of Agriculture; and C. M. Brown is Associate Professor of Agronomy, University of Illinois. They are examining Albion, a resistant variety. Some Clintland, a susceptible variety, appears at the very bottom of the photograph.

Symptoms and Effects

Early symptoms are yellow-green blotches which appear first near the tips of the leaves, then enlarge and extend downward to the stems. Later, affected areas may turn red or, in severe cases, plant tissues may die as the infection spreads through the plant. Infection is most serious in seedlings, susceptible plants being badly dwarfed and finally killed. The infection may also reduce the number of florets and cause variable blasting. Root systems are damaged as severely as the tops.

A Resistant Strain Sought

At present, the development of resistant varieties seems to be the most feasible method of controlling the disease. Through cooperative efforts of the Illinois Experiment Station and the U. S. Department of Agriculture, several resistant strains were found in the world oat collection, which consists of about 3,000 entries.

Dr. R. M. Endo of the Department of Agriculture staff began screening the entries in 1955. Virus-carrying aphids obtained from greenhouse cultures at Urbana were placed by means of a small brush on each entry in the field. The inoculated plants were observed for their reaction and the BYD-resistant ones were selected.

Albion, C.I. 729, an oat variety grown in the North Central states about 30 years ago, offers the best source of resistance. It is, however, very susceptible to other diseases, has weak straw, and produces grain of rather low test weight.

Crosses and Selections

To eliminate the undesirable characteristics of Albion, it was crossed with the adapted varieties Newton, Fayette, Clintland, and Clarion. After each cross, selections for resistance were made in the field and in the greenhouse.

Many of the segregating plants are as resistant to BYD as Albion. Most of them are superior to Albion in test weight and in resistance to rusts and lodging; but they are not as good in these respects as many of the well-adapted varieties. New varieties will therefore not be available from this method until additional crosses and selections have been made to remove the deficiencies.

Backcrosses

The backcross method is also being used to produce BYD-resistant varieties. A well-adapted variety (recurrent parent) is crossed with a resistant variety (non-recurrent parent). Resistant plants are selected from the cross and then crossed back to the recurrent parent. This procedure is repeated six or seven times, or until a desirable resistant type is produced. As many as four backcrosses following the original cross have been made using Albion as the non-recurrent parent and Clintland type, Minhafer, and Goodfield as recurrent parents.

On the basis of greenhouse tests to date and field tests in 1960, it appears that well-adapted oat varieties with resistance to BYD can be made available by this method within a few years.

However, we know that different strains of BYD virus occur in nature which vary in their virulence and the ease with which they are transmitted by aphids. We still have to investigate the effects of these variations on the performance of varieties now resistant to BYD.

New Associate Director of Extension Service: Dr. Claar Succeeds Dr. Kammlade

Dr. Claar with Dr. Kammlade in the Associate Director's Office.

Dr. John B. (Jack) Claar became the new Associate Director of the Illinois Agricultural Extension Service on September 1. He succeeded Dr. W. G. Kammlade, who retired August 31 after 45 years at the University of Illinois.

In accepting this appointment, Dr. Claar is returning to his native state. He was born and reared in Watson, Illinois, and attended Blackburn College in Carlinville from 1940 to 1942. After serving in the U. S. Air Corps from 1943 to 1945, he graduated from the University of Illinois College of Agriculture in 1947. He received his M.S. degree from the University in 1948 and his Ph.D. degree in 1959.

A recognized authority in agricultural economics and farm management, he worked with the Sangamon Valley Farm Bureau Farm Management Service from 1947 to 1951, leaving there to join the College of Agriculture staff as farm management specialist and state leader of Farm Bureau Farm Management fieldmen. He was appointed chief of the farm management extension branch of the Federal Extension Service in 1955; and administrative field representative of the Federal Extension Service in 1958.

Dean Louis B. Howard of the College of Agriculture says, "The University of Illinois and its College of Agriculture are extremely fortunate in finding an associate director who thoroughly knows and understands Illinois agriculture, who combines high educational achievement with practical field experience, and who has had broad administrative responsibilities at both state and federal levels of agriculture."

Unlike Dr. Claar, Dr. Kammlade is not a native of this state. He says, "Although I intended to be born in Illinois, the Wisconsin location of my parents made birth in Illinois inconvenient."

Dr. Kammlade, however, early became a "Sucker" by adoption. On August 11, 1915, the date of his twenty-third birthday, he was appointed half-time assistant in animal husbandry at the University of Illinois, having received his B.S. degree from the University of Wisconsin the previous June.

Ever since then he has been on the staff of the University of Illinois. During that time he had two years' leave to serve in the armed forces during World War I and one year's leave to study at the Utah State College. When first on the staff of the University, he also did graduate work, receiving both his M.S. and Ph.D. degrees here.

From 1921 until he was appointed Associate Director in 1949, he served as head of the Sheep Division of the Department of Animal Science. During those 28 years he combined research on the management, breeding, and feeding of sheep with his administrative duties. He is the author of a well-known college textbook, *Sheep Science,* as well as of numerous bulletins and articles. Until recently he served as chairman of the committee in charge of the University's 5,000-acre Dixon Springs Experiment Station in southern Illinois.

Just before his retirement, Dr. Kammlade wrote, "This is not wholly unexpected, as I was told in 1915 that the job might not last." And, in a more serious vein, he added, "I owe, but cannot fully express, thanks to thousands. I dare not name any, for if I did I might name the great and omit the humble and obscure to whom I am most deeply in debt."

COMING EVENTS

(A partial list of meetings scheduled at Urbana)

Oct. 6-7: Annual Veterinary Medicine Conference

Oct. 22: Little International Horse Show

Oct. 28: Annual Sheep Day

Nov. 17: Farm Structures Day

Dec. 1-2: Illinois Turfgrass Winter Conference

Dec. 10: Illinois Purebred Sheep Breeders Association — Bred Ewe Sale

RESEARCH IN BRIEF

Heritability of Traits in Cottonwood Trees

The possibilities of breeding better trees for the future are being studied by the Department of Forestry. Eastern cottonwood is being studied first because of its great commercial importance in Illinois and because of its dioecious habit and the ease of reproducing it vegetatively. This study is believed to be the first one ever designed to measure the inheritance of different traits in wild populations of a tree species.

Foresters have long been aware that variations within a tree species are heritable. The nature and magnitude of heritable differences have remained largely unknown, however, because they have been obscured by environmental differences. With the rapid development of tree-improvement programs in recent years, it is becoming increasingly important that we learn more about the inheritance of economically important traits. These include growth rate, form, fiber characteristics, and wood density.

Plantings of 100 lots of cuttings (clones) and 100 lots of seedlings for which one parent is known (half-sib groups) have been made on the Robert Allerton Estate and in the Illini Forest Plantation near the campus. Three populations of native Illinois trees are represented in these plantings.

Data from the clones will be used to measure heritability ratios in their broadest sense. These relate to the heritable portion of the differences between individuals. They will be useful in contrasting the functions of heredity and environment in producing the individual tree.

Heritabilities in their narrow sense will be measured from data on half-sib groups. These ratios will measure the average difference between parents that can be expected to be recovered in their offspring.

According to early observations, hereditary causes accounted for 55 percent of the variation in height growth of these cottonwood seedlings during their first season. The seedlings were later planted in field plots for long-term studies.

Phenotypic and genotypic correlations between various traits will also be measured. — *J. J. Jokela*

A New Way of Sorting Sweet Peppers From Hot Ones

To develop commercial sweet peppers with resistance to verticillium wilt, some varieties have been crossed with wild pepper plants which have this resistance. Unfortunately these wild varieties have hot fruits, and both hot- and sweet-fruited plants result from the cross. Eliminating the hot plants by tasting the fruits is most disagreeable and also makes the taster ineffective for some time. The Department of Horticulture has therefore developed a chemical method of sorting out the hot peppers.

The hot taste in peppers is due to the alkaloid capsaicin, which is one of a group of chemical compounds known as phenols. To determine the presence of capsaicin, a crude extract of the fruit is placed in a small spot on a strip of filter paper. The end of the paper is then put in a solvent that will move up the paper, carrying capsaicin along if it is present and leaving other phenols behind. Then the paper is sprayed with an acid which forms a blue complex with phenols. If capsaicin is present a blue spot appears part way up the paper. This method is known as paper chromatography.

Capsaicin is also found in the leaves of hot varieties but in concentrations too low to be detected by the human tongue. If leaves could be used for the chemical test, plants could be screened while seedlings, thus saving much valuable time in a breeding program.

If chemical tests of leaves prove unsuccessful, insects may be of use to us. Some insects detect and avoid leaves containing relatively little capsaicin. Unfortunately, this means that they molest the desirable plants we want to retain. Recently, for example, cockroaches seriously damaged many young pepper plants in the horticulture greenhouse, but left others untouched. After the molested plants recovered and grew to maturity, they were found to be sweet while the unharmed plants were hot.

German entomologists have found that small amounts of capsaicin can

kill potato beetle larvae, and they believe that is why the hot peppers grown extensively in southeastern Europe are resistant to potato beetles.

A method of breeding hot pepper varieties with intermediate levels of pungency is needed. The paper chromatography test can be adapted to measure the level of capsaicin in breeding lines and study its inheritance. Capsaicin is purified on filter paper as before, and then the part of the paper containing the capsaicin is cut off and put in a solvent. All the capsaicin is thus transferred to the solution. Like other phenolic compounds, capsaicin strongly absorbs ultra violet light, the amount absorbed being proportional to the concentration. The amount of light absorbed by the sample can be measured with a spectrophotometer, and the percent of capsaicin in the original sample calculated from this information. — *David Dickinson*

The Requirements of Sheep for Magnesium

The importance of an adequate supply of magnesium for sheep is being studied in the Department of Animal Science.

Since roughages usually supply enough magnesium, the first aim of the studies was to devise a roughage-containing diet that was low in this element. Ground corn cobs, starch, glucose, and corn oil, supplemented with vitamins and minerals other than magnesium, offered the solution.

Lambs fed this diet did not gain well, became very tense and nervous within a few weeks, and were likely to develop severe convulsions. Intravenous doses of magnesium acetate could stop these convulsions. Otherwise the lambs soon died.

Lambs fed the above diet plus a magnesium supplement gained well. It was found that more magnesium (0.07 percent) was needed to maintain normal levels of magnesium in the blood than to produce normal weight gain and prevent nervous symptoms (less than 0.04 percent). Lambs receiving less than 0.06 percent magnesium in the ration excreted more of this element than they received.

In some trials calcium and phosphorus levels in the ration were varied within and above the normal range for these elements. The variations did not affect the amount of magnesium required for growth or for the maintenance of normal blood magnesium levels. — *R. M. Forbes*

Hand Laundering Not Necessary for Wash-and-Wear

It isn't necessary to launder all wash-and-wear clothes by hand and drip them dry to avoid wrinkles. They wrinkle less if they are washed in an automatic washer at 120° F., spun to remove excess water, and dried in a tumble dryer at temperatures between 140° and 175° F. At least, this was the most satisfactory of six laundering methods tried on blouses made of four wash-and-wear fabrics. Washing at 120° F., spinning out excess water, and line drying caused the most wrinkling. Tests were conducted in the Department of Home Economics.

Although blouses were nearly wrinkle-free after tumble-drying, all the blouses, regardless of laundering method, needed steam-pressing of seams, collars, cuffs, and facings before they could be worn for "dress-up" occasions.

To measure dryer temperatures, the lint trap was removed after 15 minutes of operation and a thermometer was held in the exhaust duct. (A candy or meat thermometer will work at home.) If dryer temperatures go over 185° F., the heat may set wrinkles into the fabric. The clothing may also wrinkle if it isn't removed from the dryer as soon as it is dry. — *Jean Hunt Baldwin and Ruth Galbraith*

June Graduates Find Varied and Rewarding Opportunities

WARREN K. WESSELS

GOOD STARTING SALARIES in business, education, and related fields have awaited the young men and women who received their B.S. degrees in agriculture last June. The range has been from $4,000 to $6,000, with most of the salaries falling between $4,500 and $5,500. The average has been $4,950.

Of 121 graduates (not including those who received degrees in home economics), 15 have gone into agricultural business and industry. Jobs in this area have been varied, including work with farm equipment and with a commercial seed company, sales and service, food merchandising, and management of such enterprises as an elevator, a farm, a dairy plant, and a floral shop.

Educational work has attracted 14 of the graduates, who have become either vocational agriculture teachers or assistant farm advisers. Another 14 have gone into farming.

Seven have taken miscellaneous jobs. Of these, one has become a U. S. Department of Agriculture livestock marketing specialist, one has become a herdsman, and the others have taken work with the Cooperative Crop Reporting Service, the Soil Conservation Service, and the Food and Drug Administration.

Seven of the graduates had not yet made a job decision when these figures were tabulated last summer.

Of the remaining 53 percent, about half are going on into graduate work or professional training, and the other half are going into military service.

Warren K. Wessels is Assistant to the Dean.

FARM BUSINESS TRENDS

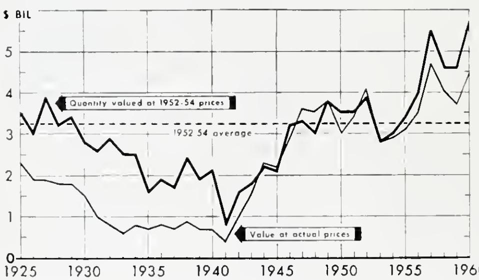
Foreign consumers are very important to farmers in the United States. In the fiscal year ended last June 30, they took more than 4.5 billion dollars worth of U. S. farm products.

About 71 percent of the year's exports represented sales for dollars. The remaining 29 percent consisted of sales for foreign currency, foreign aid, and gifts. Sales for U. S. currency brought in 3.2 billion dollars, 800 million more than in the previous year.

The physical volume of exports reached a new record high. They represented the production from one acre out of every six harvested.

Wheat and flour, valued at 876 million dollars, ranked first in total value among the farm exports. Shipments to foreign countries were equivalent to 511 million bushels, and were equal to about one-half of the U. S. 1959 crop. Biggest taker of our wheat is India. Other important buyers include Japan, Jugoslavia, Brazil, Pakistan, England, the United Arab Republic, West Germany, Poland, the Netherlands, Taiwan, Venezuela, Israel, and Korea.

Cotton was the second most important agricultural export. About 823 million dollars' worth was shipped to users in other countries. Leading buyers were Japan, England, Italy, France, Korea, West Germany, Spain, Taiwan, Canada, and Jugoslavia.



U. S. farm exports: volume and value, years ending June 30, 1925-1960. Volume of farm exports reached an alltime high in 1959-60, while value was second only to that of 1956-57.

Feed grains exported were valued at 533 million dollars. Of these, 65 percent were corn; 27 percent, sorghum grain; and 8 percent, oats. The ranking corn buyers are England, the Netherlands, Canada, West Germany, Belgium, Japan, and Austria. Principal buyers of the sorghums are Belgium, the Netherlands, England, and West Germany. The Netherlands and West Germany take most of our oat exports.

Soybeans worth 306 million dollars were sold to foreign countries in the fiscal year ended last June. Principal buyers were the Netherlands, Canada, West Germany, Denmark, and England. In addition about 100 million dollars worth of soybean oil was sold, mostly to Spain. Canada and other countries took 40 million dollars' worth of soybean meal. Altogether, exports of soybeans and soybean products were equivalent to about two-fifths of the total beans produced for commercial use.

Tobacco exports for the year were valued at 339 million dollars. The big buyers were England, West Germany, Australia, Japan, Denmark, Ireland, the Netherlands, and Belgium.

Rice buyers in other countries took two-fifths, or 137 million dollars' worth, of the 1959 crop. Cuba was the leading buyer, followed by Indonesia, Pakistan, Ceylon, and West Germany.

Animals and animal products exported were valued at 582 million dollars. Principal items were tallow, hides and skins, lard, non-fat dry milk, poultry, pork, variety meats, dried whole milk, eggs, beef, and veal. The leading buyers were: tallow — Italy, Japan, and the Netherlands; hides and skins — West Germany, Canada, the Netherlands, and Mexico; lard — England and Cuba; poultry — West Germany and Switzerland; pork — Cuba; variety meats — West Germany; dried whole milk — Venezuela; eggs — Venezuela and West Germany; and beef — Canada.
— *L. H. Simerl*

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Winter, 1961

ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

IN THIS ISSUE

Research in this laboratory kitchen has modified some of the recommendations for designing kitchens in the home (page 12).

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ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

CONTENTS

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Louis B. Howard ....Dean and Director
Tom S. Hamilton ....Associate Director
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RESEARCH IN THE DEPARTMENT OF DAIRY SCIENCE applies the modern tools of science to the problems of producing milk from feeds not directly consumable by man. The immediate objective is to aid dairymen in the profitable production of a safe, quality product. The ultimate objective, in the interests of public health, is to provide the consumer with wholesome food that economically supplies needed nutritive elements, especially high-quality protein.

Each technological application must be built on sound scientific fact, gained from probing as deeply as possible into basic principles. For example, the reason why cattle refuse to eat some legume forages grown on well-managed land was found only by studying the response of cell catalysts (enzymes) to a drug obtained from an exotic plant grown in Africa.

To reduce the loss of energy as combustible gases formed in the rumen, or to increase the efficiency of the upgrading of protein, it is necessary to study the nature and workings of microorganisms in the rumen. Reducing, through mechanization, the human labor spent in feeding cattle requires a clear understanding of cattle's nutritive requirements. Safe recommendations for breeding better cattle can be made only after trial of mating systems with cattle or with more economical pilot animals.

Protein, an item of deficit in the world's food supply, is produced in greater amounts and with more economy by the mammary gland cells of cows than by any other animal tissue. Can this capacity be improved by any method other than the slow process of genetic change? Can the rate of change be modified?

These and other important and difficult problems are being studied in the department. In time the results will become part of Illinois dairy farming practice and of the sum total of human knowledge. — *G. W. Salisbury, Head of the Department*

Dr. Salisbury came to the University of Illinois from Cornell University in 1947. His special field is the physiology of reproduction of domestic animals. In 1955-56 he was Fulbright Lecturer at Wageningen, the Netherlands.

How big is a one-man farm?

F. J. REISS

A BEGINNING FARMER has a big stake in knowing whether a farm will be large enough to provide full employment for himself and a satisfactory living for his family. Similarly, he needs a good indication of the kinds and amounts of capital required for a good start in farming.

The knowledge as to what constitutes a minimum-size, one-man farm is important to other groups as well. Landlords, obviously, should know whether their farms will provide full employment to their tenants. If a unit is below minimal size for a one-man farm, tenants will need either permission to farm additional land, or improvement capital to enlarge the volume of business within the unit.

In passing on loan applications from beginning farmers and from farmers who want to expand their operations, lenders are interested in what constitutes an efficient one-man operation. This knowledge is also a valuable guide to owners and their attorneys when they are planning the transfer of farmland from one generation to the next. It will enable them to transfer farming opportunities rather than merely equities in farm real estate.

Data Used in This Study

To get some idea of the acreage and capital associated with a one-man operation, we analyzed records kept in 1959 by tenant-operators enrolled in the Farm Bureau Farm Management Service. Basing the analysis on tenant-operated farms brings in a second party, the landlord, as a source of real estate and other forms of capital.

There were 1,543 all-rented farms in the Farm Bureau Farm Management Service in 1959, all of which contributed complete and accurate records for the year. Of this number, 681 were classified as one-man farms. Included in this classification were all farms that required less than 15 months of labor a year. The present analysis has been limited to selected groups within the 681 total.

Size of Farm

All the farms included in this analysis were in the upper range of soil productivity. Despite this uniformity in soil quality, there was considerable variation in the acreage associated with one man's labor (Table 1). One-third of the farms were smaller than 180 acres (averaging 154 acres) and two-thirds ranged from 180 to 339 acres (averaging 248 acres). The range in acres of tillable land was similar.

Why these differences? We cannot determine the answer from available data, but some possible explanations do present themselves. Among them are differences in managerial capacity among operators, in amount of livestock and volume of production per acre, in size of ownership units, and in capital and other financial resources of the operator. We would perhaps expect that the operators of some of the smaller units weren't working to full capacity and that the operators of some of the larger units were slighting part of their responsibilities.

How type-of-farming or intensity of livestock affects size of farm is indicated in Table 2. Grain farms operating under crop-share and crop-share-cash leases averaged 255 acres in size and had 241 acres tillable. On the other hand, 76 farms with similar soils, but organized and operated as fat-stock farms, averaged only 200 acres in size, with 183 acres tillable. Increasing the volume of livestock on fat-stock farms by bringing in the landlord's capital and financial resources under a livestock-share lease, apparently had little effect upon the size of the one-man unit. Average size of 115 farms under livestock leases was 205 acres, with 186 acres tillable. Intensity of land use was, however, slightly less on these farms than on the former group.

Volume of Work

Ranges in the volume of work among these groups of one-man farms can be obtained by comparing corn, soybean, hay, and pasture acreages, numbers of dairy cows, hundredweight of beef cattle and sheep produced, and litters of pigs farrowed per farm. High acreages in the major clean-tilled crops are associated with low volumes of livestock and vice versa. On the 161 one-man grain farms, the average operator grew 176 acres of corn and soybeans. He had 21 acres in hay or pasture, with the rest of the tillable land in small grains or other crops. Average livestock volume on these farms was one dairy cow, nine litters of pigs, and a yearly production of 4,600 pounds of beef or mutton.

The average operator among the

F. J. Reiss is Associate Professor of Farm Management. He became especially interested in the characteristics of a one-man farm while he was leader of the north central regional project, "How young families get started in farming."

115 livestock-share tenants had 106 acres of corn and soybeans, 49 litters of pigs, and a beef or mutton production of 37,800 pounds. Assuming that this weight was all beef and that steer calves make an average gain of 500 pounds per head, then the average farm in this group would have had about 75 cattle.

Capital Investment

Tenants' average investment ranged from about $13,000 to about $21,000 in the various farm groups. In each case, beginning-of-year inventory in livestock, feed, grain, and seeds accounted for more than half of the total. It can be argued that these inventories represent stocks on hand which yield an income flow. However, only a part of these inventories represent salable stocks. The rest are truly capital items needed for the full employment of labor and the production of income. Furthermore, if there is not this source of income flow, then it will be necessary to draw upon savings or other resources to meet current expenditures, including those for family living. Livestock, feed, grain, and seeds must therefore be considered part of the beginning farmer's capital requirement.

A capital item that is vivid in the minds of beginning farmers, lenders, landlords, and others is the investment in machinery and equipment. This type of capital averaged about $6,500 on the farms studied. If this seems low in relation to new machinery prices, it's because the figure is based on remaining costs taken from capital account depreciation schedules. One might describe these costs as representing conservative, used-machinery prices. It would take at least twice as much money to replace this machinery and equipment.

Providing for the replacement of machinery and other capital that wears out is an important item in figuring capital needs. Replacements can often be postponed for short periods. Eventually, however, they must be made or there will be a gradual disinvestment and decrease in the operator's capital position. Depreciation charged on the tenants' capital amounted to about 8 to 10 percent of their total investment.

A picture of the total capital associated with one man's labor must include the landlord's contribution of real estate and operating capital. In our farm accounts land is conservatively valued at an average of $440 an acre for bare land with a productivity rating of 85, and $325 with a productivity rating of 68. Even so, the landlord's capital contribution, including buildings, fences, and other improvements, is more than $100,000 a man. The size of this figure emphasizes the importance of tenancy to young farmers who want enough land and capital to utilize their labor efficiently.

Capital inputs by livestock-share

Table 1. — Landlord and Tenant Capital Structure, Organization, and Earnings on One-Man, Tenant-Operated Farms by Size of Farm and Type of Lease[a]

(From 1959 records on all-rented farms in the Farm Bureau Farm Management Service)

Item	Crop-share and crop-share-cash leases: Under 180 acres	Crop-share and crop-share-cash leases: 180-339 acres	Livestock-share leases: Under 180 acres	Livestock-share leases: 180-339 acres
Number of farms	70	181	63	79
Total acres per farm	154	249	153	245
Tillable acres per farm	145	232	143	222
Average soil productivity rating[b]	85	85	84	84
Acres in corn and soybeans	95	162	82	135
Acres of tillable land in hay and pasture	22	28	29	41
Average number of dairy cows	4	1	2	1
Hundredweight of beef cattle and sheep produced	58	84	295	332
Litters of pigs farrowed	21	19	49	36
Total months of labor per farm	12.3	12.7	12.7	13.0
Tenant's share in the farm business				
Values at the beginning of the year for:				
Inventory of livestock, feed, grain, and seeds	$ 8,995	$10,806	$11,903	$13,496
Remaining cost of machinery, equipment, buildings, fence, and soil fertility[c]	5,542	7,341	5,723	7,038
Total investment	14,537	18,147	17,626	20,534
Total depreciation charged	1,386	1,795	1,520	1,877
Tenant's cash income from:				
Feed, grain, and seeds	$ 2,918	$ 5,872	$ 1,127	$ 2,868
Livestock, livestock products, and other sources	10,926	9,439	15,042	14,793
Total cash income	13,844	15,311	16,169	17,661
Tenant's expenditures for:				
Total capital purchases	$ 1,600	$ 1,879	$ 1,450	$ 2,229
Feed and grain	3,584	2,816	3,271	2,171
Livestock purchases	2,112	2,603	5,287	5,787
Farm operating expenses	3,488	4,421	3,223	3,821
Tenant's total cash expenditure	10,784	11,719	13,231	14,008
Tenant's cash balance	$ 3,060	$ 3,592	$ 2,938	$ 3,653
Returns to unpaid labor, capital, and management	2,316	3,184	1,696	3,207
Unpaid labor charged	2,566	2,596	2,600	2,605
Landlord's share in the farm business				
Values at the beginning of the year for:				
Inventory of feed, livestock, grain, and seeds	$ 2,847	$ 4,504	$11,315	$13,104
Remaining cost of machinery, equipment, buildings, fence, and soil fertility[c]	10,074	12,002	17,421	19,223
Land	68,244	109,378	67,003	105,229
Total investment	81,165	125,884	95,739	137,556
Total depreciation charged	834	944	1,636	1,821
Landlord's total cash income	$ 4,302	$ 7,294	$15,225	$16,669
Landlord's total cash expenditures	1,939	2,767	12,852	13,338
Landlord's cash balance	2,363	4,527	2,373	3,331
Returns to unpaid labor, capital, and management	2,314	4,236	1,375	2,999
Unpaid labor charged	0	0	5	8

[a] One-man farms are all those with less than 15 months of labor.
[b] Only farms with soils rated 76 to 100 in productivity were included.
[c] Includes farm share of auto.

Table 2. — Landlord and Tenant Capital Structure, Organization, and Earnings on One-Man, Tenant-Operated Farms by Type of Farm and Type of Lease[a]

(From 1959 records on all-rented farms in the Farm Bureau Farm Management Service)

Item	Crop-share and crop-share-cash leases		Livestock-share leases	
	Grain farms	Fat-stock farms	Dairy and poultry farms	Fat-stock farms
Number of farms	161	76	22	115
Total acres per farm	255	200	188	205
Tillable acres per farm	241	183	165	186
Average soil productivity rating[b]	85	84	68	83
Acres in corn and soybeans	176	112	68	106
Acres of tillable land in hay and pasture	21	34	58	38
Average number of dairy cows	1	0	27	1
Hundredweight of beef cattle and sheep produced	46	149	2	378
Litters of pigs farrowed	9	43	22	49
Total months of labor per farm	12.6	12.9	13.1	13.0
Tenant's share in the farm business				
Values at the beginning of the year for:				
Inventory of feed, livestock, grain, and seeds	$ 7,996	$14,520	$ 8,211	$14,230
Remaining cost of machinery, equipment, buildings, fence, and soil fertility[c]	6,801	7,112	4,978	6,735
Total investment	14,797	21,632	13,189	20,965
Total depreciation charged	1,680	1,777	1,448	1,772
Tenant's cash income from:				
Feed, grain, and seeds	$ 7,172	$ 2,610	$ 1,227	$ 1,402
Livestock, livestock products, and other sources	4,979	17,562	7,600	17,320
Total income	12,151	20,172	8,827	18,722
Tenant's expenditure for:				
Total capital purchases	$ 1,790	$ 1,944	$ 2,217	$ 1,963
Feed and grain	1,260	5,820	1,104	3,162
Livestock purchases	1,339	4,800	838	6,573
Farm operating expenses	4,284	4,285	3,079	3,553
Tenant's total cash expenditures	8,673	16,849	7,238	15,251
Tenant cash balance	$ 3,478	$ 3,323	$ 1,589	$ 3,471
Returns to unpaid labor, capital, and management	3,532	1,890	2,758	2,359
Unpaid labor charged	2,525	2,666	2,639	2,616
Landlord's share in the farm business				
Values at the beginning of the year for:				
Inventory of livestock, feed, grain, and seeds	$ 4,709	$ 3,337	$ 7,561	$13,699
Remaining cost of machinery, equipment, buildings, fence, and soil fertility[c]	11,501	11,649	17,030	18,324
Land	112,981	86,300	61,015	87,080
Total investment	129,191	101,286	85,606	119,103
Total depreciation charged	907	962	1,509	1,702
Landlord's total cash income	7,605	5,525	8,382	17,755
Landlord's total cash expenditures	3,057	2,340	5,994	14,680
Landlord's cash balance	4,548	3,185	2,388	3,075
Returns to unpaid labor, capital, and management	4,545	2,966	2,785	2,207
Unpaid labor charged	0	0	29	8

[a] One-man farms are all those with less than 15 months of labor.
[b] Dairy and poultry farms ranged from 56 to 75, the others from 76 to 100.
[c] Includes farm share of auto.

landlords are substantially higher than those of crop-share and crop-share-cash landlords. This usually is additional capital and not a transfer of capital requirements from tenant to landlord. As a matter of fact, tenants with livestock-share leases tend to have greater investments than those with crop-share leases.

The livestock-share tenant is associating his labor and managerial ability with a larger volume of business, as well as a larger total capital investment. Thus, he is presumably marketing larger inputs of management. With normal price relationships, the result should be higher returns for unpaid labor, capital, and management. Earnings in 1959, however, do not show this, for price relationships were relatively unfavorable for livestock enterprises.

Returns to Labor, Capital, and Management

In general, operators' earnings on these one-man farms were low in 1959. Returns equaled only about the value of unpaid labor, leaving little or nothing as a return on the tenants' capital and management.

Tenants' cash balances averaged slightly over $3,000. This relatively small amount had to cover interest on indebtedness, income and social security taxes, family living expenses, and any debt retirement or savings.

The superior earning power of the larger farms is indicated in Table 1. Landlords of these farms, as well as the tenants, received higher returns to unpaid labor, capital, and management. Despite the higher total investment, the landlord's rate of return on capital investment was greater on the larger farms than on the smaller farms.

When earnings are compared on a type-of-farm basis, the grain farms and the dairy and poultry farms showed the highest returns. These two types represent the extremes in average size among the groups in our analysis.

The dairy and poultry farms overcame their size handicap by favorable price relationships. The small cash balance for these farms resulted from an inventory build-up. Thus, credit was probably required to meet family needs even though net earnings, including inventory increases, were favorable.

How Big a Farm?

It would appear from these data that, with a typical Illinois operation, the one-man farm should be 180 to 240 acres. The best size would, obviously, vary with individual circumstances.

Certainly operator and landlord, borrower and lender, have a mutual interest in finding the most satisfactory level of capital investment. This is the level which, when associated with the labor and managerial capacities of the operator, will yield the highest return on the investment and provide an adequate family living for the operator.

WATER USE BY ROW CROPS

Reducing evaporation from the soil would greatly increase the moisture available to crops, and water would seldom be a problem in Illinois

M. B. RUSSELL and D. B. PETERS

WATER is essential for all living things. Every year tremendous quantities of this life-giving substance reach the earth's surface as rain or snow and either enter the soil, flow over the surface to drainage channels, or return to the atmosphere as vapor.

In Illinois each acre of land receives 3,000 to 5,000 tons of water a year. About 80 percent of this is returned to the atmosphere, either by evaporation from the soil surface or by transpiration from the leaf surfaces of growing plants.

Sun Supplies Energy for Evaporation and Transpiration

The rate at which water returns to the atmosphere depends mainly on how much energy is available to transform water into vapor. Large amounts of energy are necessary for this purpose. Under Illinois conditions, it would take 200 to 300 tons of coal or 50,000 gallons of gasoline a year to supply as much energy as is used in evaporation and transpiration on each acre of land.

This huge quantity of energy is supplied by the sun in the form of radiant energy. The amount of radiation reaching the soil and leaf surfaces is largely determined by day length and degree of cloudiness. Consequently, the rates of evaporation and transpiration vary greatly according to season.

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Seasonal variations in water use and in rainfall are shown in Figure 1. Potential evaporation and transpiration are less than rainfall during the fall, winter, and early spring, when days are relatively short and cloudy; but water use is greater than normal rainfall during the summer. This is the fundamental problem in water management. To supply the extra water needed during the summer, the soil has to store some of the excess water from the rest of the year. The moisture-storage capacity of the soil, especially the subsoil, becomes important in bringing seasonal water supply and demand into balance.

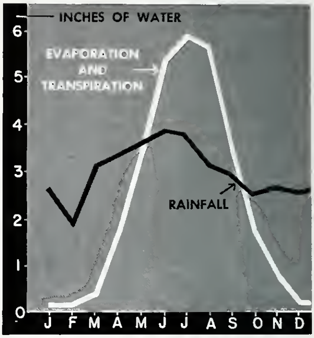
Subsoil Reserves and Corn Yield

To find out how water reserves in the subsoil affect corn yields, we covered some plots with plastic during the fall and winter. This kept the subsoil from being normally recharged. The subsoil was, however, partially recharged by rain after the plastic was removed in the spring.

Yields were substantially lower on these plots than on adjacent plots where the subsoil had been completely recharged (Table 1). Small irrigations that only moistened the topsoil did not overcome the yield deficiency created by low subsoil moisture, even though total water use was substantially increased.

Variations in Soils

Soils differ a great deal in their ability to store and retain available moisture. The moisture-retention capacities of some typical Illinois soils are given in Table 2. Group I soils illustrate how soil texture in-



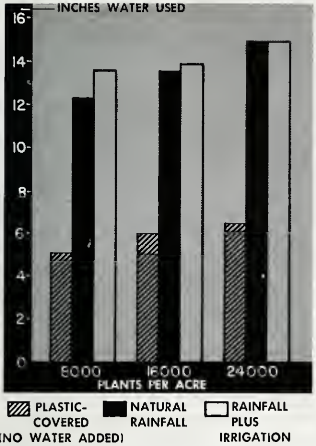
Average monthly rainfall and amount of water lost through evaporation and transpiration in central Illinois. (Fig. 1)

fluences moisture retention. Sandy soils such as Watseka do not retain much moisture. Summer rainfall is much more important on these soils than on the finer textured soils such as Muscatine silt loam. Fortunately, most agricultural soils of Illinois have high moisture-retention capacities.

However, such capacities are not in themselves enough to insure that the growing plant has an adequate supply of water. Just as important are the soil properties which permit or limit the expansion of roots. Some Illinois soils have such dense sub-

Table 1. — Effect of Subsoil Reserves on Corn Yields

Source of water	Total water use, inches	Yield, bu./A.
Recharged subsoil		
Natural rainfall.........	13.8	81
Rainfall and irrigation...	17.7	97
Partially recharged subsoil		
Natural rainfall.........	12.4	51
Rainfall and irrigation...	16.1	79



Water use by corn, as affected by covering soil surface and by increasing number of plants per acre. (Fig. 2)

soils that it is difficult or impossible for roots to penetrate them.

A few such soils are listed under Group II, Table 2. They are typical of soils in northeastern Illinois which have glacial till subsoils of high density. Plant roots cannot easily penetrate the lower depths of these soils; hence the water stored there is largely unavailable for plant use. Group II soils thus need summer rain more urgently than Group I soils.

Table 2. — Available Moisture-Holding Capacities of Some Illinois Soils

Soil type	Inches of available water: To depth of 5 ft.	Inches of available water: In probable rooting depth
Group I		
Watseka loamy fine sand	2.3	2.3
Onarga fine sandy loam	8.7	8.7
Muscatine silt loam	11.9	11.9
Group II		
Swygert silt loam	8.4	3.5
Saybrook silt loam	10.6	6.6
Elliott silt loam	12.4	6.7
Group III		
Cowden silt loam	14.1	6.0
Cisne silt loam	14.4	5.4
Grantsburg silt loam	16.7	9.5

The soils of Group III have moderately dense subsoils which are quite infertile. Research has shown that where these soils are adequately fertilized and good management practices followed, the water in the lower depths can be used by plants.

Adjusting Water Use

On an average summer day in Illinois, evaporation and transpiration use about 70 percent of the absorbed radiant energy from the sun. Only 5 percent or less is utilized by photosynthesis; about 10 percent is used in heating the soil, and 15 percent in heating the air adjacent to the soil and plant surfaces.

How would a decrease in the amount of evaporation affect water use by row crops? To find the answer to this question, we controlled evaporation from corn and soybean plots in two ways. One way was to cover the soil surface with a waterproof plastic, thus essentially stopping the loss of water by evaporation. Then the only water lost was through transpiration.

Changing the number of plants per acre was another method of modifying water use. As plant population is increased, a greater proportion of the incoming solar energy is absorbed by the crop, leaving less available for evaporation.

Results of the two treatments on corn are summarized in Figure 2. The plastic-covered plots used only about half as much water as the uncovered plots. Thus 50 percent or more of the total water used to grow corn is actually lost through evaporation rather than utilized by the crop itself. Obviously, if some practical method could be devised to prevent or greatly reduce evaporation from the soil, water would rarely be a problem in Illinois. Nearly all our soils retain enough water to meet transpiration needs.

The effects of increasing plant population vary with the amount of moisture in the surface soil. The number of plants per acre did not greatly affect total water use when there was an ample water supply (Fig. 2). As the plant population is increased, more water is used by transpiration, but this is largely balanced by a decrease in evaporation. If the soil surface has been dry for some time, however, evaporation is already so low that it cannot be reduced much more. Increasing the plant population (and hence transpiration) under such conditions can increase water use to the point of becoming critical.

The water used by soybeans in 20- and 40-inch rows during a dry season is shown in Table 3. Increasing plant population by reducing row width greatly increased water use. However, the plants in the narrow rows used considerably less than the 15 to 18 inches normally used when ample water is available throughout the growing season.

Summary

We have found that water use by row crops in Illinois largely depends on the amount of solar energy absorbed by the moist soil surface and the transpiring plant leaves. Under normal conditions, 50 percent or more of the water lost during the growing season is due to evaporation from the soil surface. Therefore, cutting down on evaporation would mean more efficient use of both summer rainfall and subsoil-stored water. Evaporation would be decreased if less energy were permitted to reach the soil surface or less vapor allowed to leave the soil.

When the soil surface is moist, increasing the number of plants per acre has only a minor effect on total water use. It may, however, increase total use when evaporation is limited by lack of water rather than by lack of energy.

Table 3. — Effects of Different Treatments on Water Use by Soybeans During a Dry Year

Treatment	Water use, inches
Plastic-covered, 40-inch rows	2.6
Not covered, 40-inch rows	6.3
Plastic-covered, 20-inch rows	4.3
Not covered, 20-inch rows	9.5

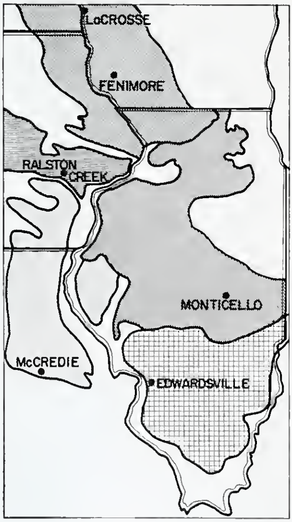
Water Losses Through SURFACE RUNOFF in Central Illinois

BEN A. JONES, JR., and ROBERT L. McFALL

Ben A. Jones, Jr., Associate Professor of Agricultural Engineering, has been on the staff since 1952. Co-author Robert L. McFall is Instructor in Agricultural Engineering.

How much water runs off from your fields during a heavy rainstorm? This is an important question to agricultural engineers who must design grass waterways, concrete structures, farm ponds, and other erosion-control structures. It is also important to you since you pay the bill for these improvements.

In 1946 the Department of Agricultural Engineering received an unusual opportunity to help answer this question for central and north central Illinois. That year Mr. Robert Allerton gave the University a large tract of land near Monticello in Piatt county. Included in the tract are the 4-H Memorial Center, Robert Allerton Park, and supporting farms. The area is well suited to studies of rainfall and surface runoff. By mid-summer of 1949 measurements were underway on two watersheds of 45.5 and 82.0 acres.



Applicability of runoff studies at Monticello, and of studies made at other research stations. (Fig. 1)

These are the first runoff studies made that have been applicable to central Illinois. The extent of their applicability is shown in Figure 1.

Typical Prairie Soils

The soils on the two watersheds are typical of central and parts of north central Illinois (Fig. 1). They are predominantly Drummer silty clay loam and Flanagan silt loam. These are moderately permeable, dark-colored prairie soils with nearly level to gently sloping topography.

Of the 82 acres in Watershed IA, 50 acres have a slope of 0 to 1.5 percent; 31 acres, 1.5 to 4 percent; and 1 acre, 4 to 7 percent. In Watershed IB, with a total of 45.5 acres, about 36.5 acres have slopes of 0 to 1.5 percent, and the rest has 1.5- to 4-percent slopes.

Grain and Livestock Operations

Two different operators farm Watershed IA. About 26.5 acres are in a corn, soybeans, grain, legume rotation; 40.5 acres in corn, oats, meadow, meadow; and somewhat less than 0.5 acre is in corn, soybeans, wheat (with a sweet clover catch crop). Of the remaining land, about 12 acres are in permanent pasture and 2.5 acres are taken up by roads.

Watershed IB is farmed entirely by one operator who has a grain-livestock enterprise. He has about 35.5 acres in a corn, oats, meadow, meadow rotation; and a little less than 10 acres in corn, soybeans, wheat (with a sweet clover catch crop). One field (about a quarter of an acre) is in permanent pasture.

Rainfall and Runoff Measured

Recording raingages measure the time and depth of rainfall at three different points (Fig. 2). This intensity of measurement is essential because peak runoff normally comes from thunderstorms which are quite variable in extent.

Surface flow passes over calibrated concrete weirs. The level of water passing over the notches is recorded on a standard waterlevel-recorder. Rate and amount of runoff are determined from these data.

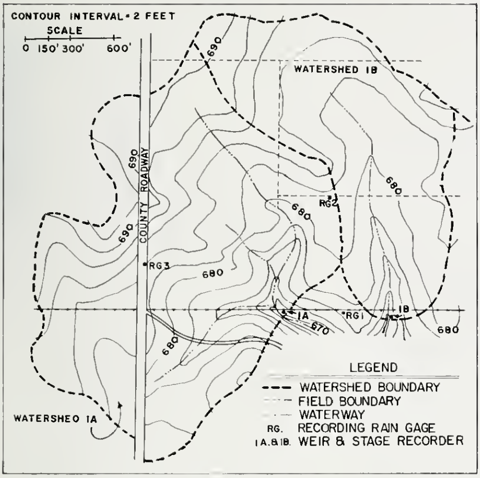
Runoff Results From Storms

Annual and growing-season precipitation for each year of the study is given in Table 1. As can be seen, the 10-year average for the two watersheds is below the 1903-1954 average for Urbana, the closest station with a long-time weather bureau record.

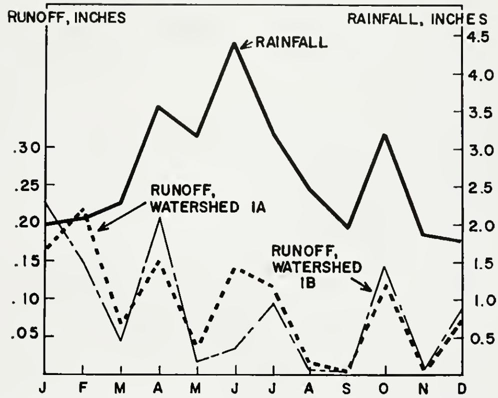
Such comparisons of precipitation indicate the "wetness" or "dryness" of a particular period. They are not, however, a good indication of runoff. Runoff is the result of individual storms, and may show no re-

Table 1. — Precipitation on Watersheds, Compared With Urbana Records

Year	Inches of precipitation: Annual	Apr.-Oct.
1950	33.46	19.04
1951	41.20	29.19
1952	32.41	21.67
1953	27.01	15.03
1954	25.78	20.02
1955	37.92	29.28
1956	25.38	18.23
1957	35.12	25.41
1958	33.41	25.95
1959	29.41	17.07
Mean	32.11	22.09
Urbana (1903-1954)	36.43	24.30



Topographic map of watersheds IA and IB. (Fig. 2)



Average monthly rainfall and runoff, Watersheds IA and IB. The largest runoffs have not necessarily occurred in the months of highest rainfall. Nor have they occurred at the same time on the two watersheds. In general, Watershed IB has had less runoff because of the better crop cover. (Fig. 3)

lationship to total precipitation for the year or for the growing season.

The lack of correlation between individual storms and total precipitation is indicated by a comparison of Tables 1 and 2. In 1950, for example, there were only six excessively heavy rains that lasted for the four lengths of time specified in Table 2, while in 1952 there were 19 such rains. Yet the two years had about the same amounts of total and growing season precipitation.

The watersheds received, on the average, more excessively heavy rains in the four time categories than did Urbana (Table 2). The difference, however, is not statistically significant, and the number of heavy rains on these watersheds can be considered representative of the long-time records.

Monthly rainfall and runoff for the two watersheds are shown in Figure 3. Here again we see that runoff and amount of precipitation are not necessarily related.

Table 2. — Number of Excessively Heavy, April-October Rains Lasting for Selected Lengths of Time, Compared With Urbana Records

Year	Number of excessive rains lasting—			
	15 min.	30 min.	60 min.	120 min.
1950	3	2	1	0
1951	8	8	6	3
1952	8	6	4	1
1953	6	5	1	0
1954	6	4	4	1
1955	3	3	3	3
1956	5	2	1	0
1957	7	6	3	0
1958	9	7	5	3
1959	2	2	1	0
Total	57	45	29	11
Aver. no./yr.	5.7	4.5	2.9	1.1
Urbana, aver. no./yr. (1916-1947)	4.7	4.1	2.6	0.80

Crop Cover Affects Runoff

As shown in both Figure 3 and Table 3, the largest average runoffs from the two watersheds have not always occurred at the same time. The two watersheds have also differed greatly in the rate of runoff. The highest rate on Watershed IA — 0.682 inch per acre per hour — was about twice as large as that on Watershed IB — 0.327 inch per acre per hour (Table 3).

Since all physical factors on the watersheds were similar, it seemed apparent that the differences in runoff were due to differences in cropping practices. When runoff storms occurred, the percentage of the steeper fields in meadow or small grains was almost always higher on Watershed IB than on Watershed IA (Table 3).

This study of two entire watersheds confirms the results of many previous experiments on small plots, and emphasizes the importance of having a sizable percentage of the land in good cover all the time.

Table 3. — Peak Runoff Rates and Crop Cover, Watersheds IA and IB

Date	Peak rate, in. per A. per hr.	Percent of steeper fields in	
		Corn	Meadow[a]
Watershed IA			
7/9/51	.682	38.4	11.1
6/27/51	.485	38.4	11.1
6/10/58	.477	38.4	11.1
5/28/55	.450	38.4	11.1
10/6/55	.317	38.4	11.1
10/21/49	.222	11.1	38.4
2/20/51	.183	0	100.0
7/11/58	.183	38.4	11.1
12/21/49	.166	11.1	38.4
Watershed IB			
10/6/55	.327	5.8	72.2
10/21/49	.298	5.8	72.2
7/9/51	.280	5.8	72.2
6/27/51	.214	5.8	72.2
12/21/49	.163	5.8	72.2
4/22/52	.125	5.8	72.2
6/10/58	.125	5.8	72.2
3/31/53	.122	44.1	33.9
7/11/58	.113	5.8	31.6

[a] Practically all of the area not in corn or meadow was in small grain.

HOW MUCH FAT ON BEEF?

B. C. BREIDENSTEIN

GIVE THE CONSUMER what he wants," seems to be the final answer to a problem that is causing much concern in the beef industry. This is the problem of how much finish, or fatness, should be on beef.

There are rare consumers who truly relish the taste of beef fat and insist on a generous "bark" on the outside of their broiling steaks. The vast majority, however, fastidiously trim all or most of the external fat from beef, as well as most of the intermuscular fat, either before cooking or at the dinner table. To them, fat is an economic waste at best, and some even consider it a health hazard.

Obviously, then, the retailer has to offer cuts without excessive waste fat. This does not mean, however, that we have to completely discard our traditional concepts of high-quality beef. Fat within the muscle (marbling) undoubtedly contributes to both the flavor and juiciness of meat, and may also influence tenderness. Furthermore, dry roasts should have a nominal amount of "cover fat" to keep them from drying out while they're in the oven.

Cut-Out Tests

Consumer preference for lean beef forces the retailer to employ at least a modest trim on retail cuts. There seems to be considerable advertising appeal in a reference to "extra trim removed," or "a high proportion of lean" in cuts offered for sale.

Effects of trim on the yield of carcasses have been studied for several years by the Meats Division of the Department of Animal Science. Cut-out tests have been carried on in conjunction with other beef cattle experiments.

The cutting procedure being followed is quite similar to that used by progressive meat retailers. All extraneous fat is removed in accordance with the standard trim requirement, which is that no more than 0.4 inch of fat be left on the outside surface of any retail cut. The round and rump are completely boneless; the backbone is removed from the sirloin, rib, and chuck; and the ribs on the rib roasts are cut to a 6-inch length. Such a procedure yields cuts to which consumers have very little, if any, objection.

Using this procedure, we have observed dramatic variation in cut-out

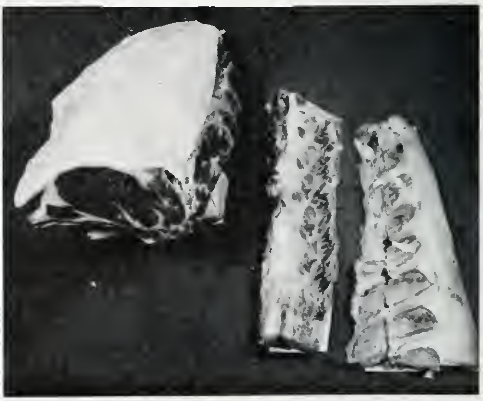
Retail Cut-Out From a Low-Yielding Individual Compared With Average Cut-Out[a]

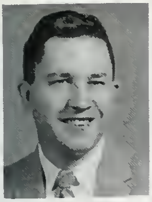
Retail cuts	Retail yields as percent of side weight: Average individual	Low-yielding individual
Top round steaks	4.51	3.14
Bottom round steaks	5.14	4.53
Sirloin tip steaks	2.58	2.18
Round lean trim	2.49	.61
Boneless rump	2.65	3.72
Shortloin steaks	5.62	4.60
Sirloin steaks	5.61	5.61
Rib roasts	5.90	4.47
Chuck arm roasts	4.26	3.98
Chuck blade roasts	10.31	9.28
Chuck lean trim	5.92	4.43

[a] Data involve 242 sides of beef processed at the University of Illinois Meats Laboratory.

Loin steaks (porterhouse, T-bone, and club) are good broiling steaks. Consumers consider that quality, as indicated by marbling, color of the lean, and age of the animal, is of paramount importance. While economy is a secondary consideration, consumers still prefer a minimum of outside fat.

Like loin steaks, standing rib roasts are purchased primarily for quality rather than economy, although consumers prefer that high quality be combined with a minimum of bone and fat waste. A standing rib may be used either as a dry oven roast or as broiling steaks.





B. C. Breidenstein, Associote Professor of Animol Science, come to the University as o groduote ossistont in 1952, receiving his Ph.D. degree in 1955. He is now working on techniques to permit criticol selection of breeding stock for meotiness.

yield from cattle which can best be described as "typical chain store cattle" — that is, grading from high Good to middle Choice. This variation is brought out in the table, which compares the yields from a selected low-yielding individual with the average yields from a group of cattle. According to current retail prices, the average carcass would be worth $6.50 a hundredweight more than the low-yielding carcass. On a live basis the difference would be about $3.90.

In considering these data, three things must be borne in mind.

1. The grade range is very narrow, and does not show the actual differences among cattle being marketed today.

2. The comparison in the table is between average yield and a low-yielding individual, rather than between an extremely high-yielding individual and an extremely low-yielding one.

3. The fat cuts of the carcass, such as the flank, plate, and brisket, are not included in the comparison. If they were, the value differential would be greater.

Implications for the Beef Industry

Needless to say, the wide differences in yield of retailable product have important implications for the retailer, as well as for the packer, producer, and consumer.

If the retailer properly discriminates against over-fat cattle, then cattle prices at the packer level, and ultimately the price paid the producer, must reflect differences in retail yield. On the other hand, if the retailer must purchase "wasty cattle" and cannot buy them at a price commensurate with their expected yield, he must pay less for "high retail yielding" cattle than they are worth, if he is to stay in business. Furthermore, if he doesn't differentiate, by his price to the packer, between "high retail yielding" and "low retail yielding" cattle, the result is high prices to the consumer. This could conceivably reduce sales and consequently the demand for cattle.

The solution to the problem seems to lie with the producer. Just as the data indicate that we have "wasty" cattle, they also indicate that our cattle population includes the kind of animal that must be produced to maintain a healthy beef industry.

Top round steaks (right) are 100 percent edible with no bone and with very little fat on the outside of the cut. Cost per serving is therefore reasonable, even though these cuts usually command a relatively high price. They are generally cooked with moist heat, such as braising.

Chuck blade pot roasts (lower left) and chuck arm pot roasts (lower right) are considered economy cuts. Consumers are interested in low-cost servings and object strenuously not only to outside fat, but to seams or pockets of fat inside the cut. Because pot roasts are cooked with moist heat, quality is relatively less important than in standing ribs or loin steaks. All cuts shown on these two pages came from the same carcass.

Kitchens to date . . .

Practical, convenient arrangements

HELEN E. McCULLOUGH and MARY B. FARNHAM

NEW KITCHEN APPLIANCES, as well as the trend toward open planning, call for some changes in the standards used in designing kitchens. This has been brought out by recent research in the Department of Home Economics. At the same time, the research has substantiated many of the results of earlier studies.

Both *conventional* and *contemporary* kitchens were used in the research. The conventional kitchen is defined as containing three basic appliances — sink, range, and refrigerator. The contemporary kitchen includes a divided range and dishwasher. (Use of a wall-hung refrigerator was tested, but because the only model made is no longer available, this part of the research is not reported.)

The kitchens consisted of centers, each complete in itself, with counter and storage space for the particular type of work carried on. The centers in the conventional kitchen were *refrigerator, mix, sink, range,* and *serve* (Fig. 1). In the contemporary kitchen the divided range added another center — the *oven*; and a dishwasher was included in the sink center (Fig. 2). The freestanding storage wall which replaced wall cabinets in one study formed a *storage* center.

An L arrangement was used in all studies except two in which an island was used, forming a corridor.

Scope and Plan of Research

The studies covered the number of trips made to, within, and between centers and total distance traveled in meal preparation, serving, and clean-up activities, as influenced by these factors: Use and location of separate oven, effect of two different locations for the mix center (between refrigerator and sink, and between sink and range), use of a dishwasher, use of a storage wall, and an island arrangement.

One menu, planned for four people, was prepared two to four times for each study. It involved the use of every center. Two women participated in the research, each in turn preparing the meal and keeping a detailed record of every trip and its purpose. The trips made by the two women were averaged to get the final results.

In all studies observation was made of counter space requirements, and of adequacy and functionalism of storage provisions.

Use of Centers

Because of the many activities involved in meal preparation and the different work habits of individuals, it was impossible to obtain identical results in repetitive tests, even under laboratory conditions. Much greater variation would, of course, be found in the home. Nevertheless, the tests showed a definite uniformity in use of centers and distance traveled.

The sink was by far the most-used center, with the range and mix centers coming next (see table). This indicates that in planning kitchens the sink should be centrally located, and close to the mix and range centers.

The women did not find much difference in convenience whether the mix center was between the refrigerator and sink or between the sink and range. However, the latter arrangement involved more travel because of the greater distance between mix center and refrigerator.

Placement of the less-used centers is not so important, except that the tall applicances — refrigerator and separate oven — should not block the counters between two centers. The sequence of centers found most satisfactory was, from right to left, refrigerator, mix, sink, range, serve, and oven (Figs. 1 and 2).

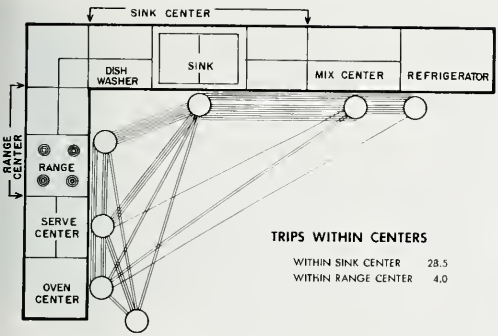
Location of doors and windows may prohibit an ideal arrangement of centers. However, *having each center complete in itself, with adequate counter and storage space,* is more important than the sequence.

Conventional vs. Contemporary

The chief difference between the conventional and contemporary kitchens was in travel distance. About 16 percent more distance was traveled in the contemporary

Conventional kitchen arrangement. (Fig. 1)

Contemporary kitchen arrangement. (Fig. 2)



TRIPS BETWEEN CENTERS

From:	To:	Av. No.
SINK	MIX	34.5
SINK	RANGE	24.5
REFRIGERATOR	MIX	11.0
SINK	SERVE	11.0
SINK	REFRIGERATOR	9.5
RANGE	SERVE	9.5
SERVE	TABLE	9 0
SINK	TABLE	6.5
RANGE	OVEN	5 0
RANGE	TABLE	3.5
MIX	OVEN	3.5
REFRIGERATOR	RANGE	3.0
SINK	OVEN	3.0
SERVE	OVEN	3.0
MIX	RANGE	2.5
OVEN	TABLE	1.0
MIX	SERVE	.5
REFRIGERATOR	OVEN	.5

Average number of trips made to prepare a meal in one study of the contemporary kitchen. This kind of floor and trip diagram was used in the reports. (Fig. 3)

kitchen. This was the normal result of using a divided range.

The dishwasher made little difference in space use. Even though it replaced storage space, storage was added under the oven and surface cooking unit.

A divided range takes more space than a conventional range. Thus, while the separate oven adds to storage, it may mean the sacrifice of needed counter space. If so, its advantages may be questioned.

Island and Storage Walls

The island arrangement, which included the range and serve counters, shifted the location of some storage from wall cabinet to base cabinet. Counter and storage were needed on both sides of the appliance in the island. Travel distance was less than in the L arrangement because the island brought major centers closer together.

Use of a storage wall violates the recommendation for storage at place of first use and adds to the number of trips and travel distance. The storage wall is, however, a good solution to the problem of inadequate wall cabinets. It also provides a good divider between kitchen and dining areas. (For more information, see Illinois Extension Circular 807.)

Counter and Storage Space Needs

Observations of the use of counters resulted in the following recommendations for space, some of which vary from earlier recommendations:

Refrigerator center, 18 inches on latch side for setting out supplies.

Mix center, minimum 42 inches, desirable 48 inches; 54 inches if mix center serves an adjacent appliance.

Sink center, 36 inches on right for stacking soiled dishes, 30 inches on left for draining and stacking clean dishes. If bowl is centered, 36 inches on each side are desirable. If a front-opening dishwasher is at *left* of bowl, the counter width of the dishwasher may be adequate for stacking clean dishes.

Range center, 24 inches adjacent to burners for storing utensils and supplies. (Heat-proof counter desirable.)

Serve center, 24 inches for setting out serving equipment and supplies, and serving food in dishes. (Space will be needed elsewhere for serving occasional large numbers.)

Separate oven, 18 inches for setting hot dishes from the oven. If adjacent to another center, no special counter is needed. (Heat-proof setting space recommended.)

Space may be saved when one counter serves two appliances, but storage space beneath the counter must also be considered. In general, adequate counter space means adequate storage space. Special provisions may be necessary for small electrical appliances and "company" dinnerware.

Design of cabinets may be more important than size. Following these recommendations will make supplies more easily accessible:

Wall cabinets. Use adjustable shelves to eliminate the need for stacking unlike articles and to eliminate waste space between shelves. In cabinets containing many small articles, use door storage and narrower shelves within the cabinet. A distance of 15 inches between base and wall cabinets is ample for the work done and equipment used on the counters, and will bring more wall cabinet space within easy reach.

Base cabinets. Drawers of proper height and with good hardware are the most functional arrangement for many supplies stored in base cabinets. Pull-out shelves rank second. Turn-around shelves solve the problem of reaching into corners.

Use of Centers, as Influenced by Location of Mix Center, Use of Storage Wall, and Use of Island

Type of kitchen or arrangement	Percentage use of center								No. of trips	Distance, feet
	Sink	Range	Mix	Serve	Refrig.	Table	Oven	Wall		
"L" kitchen, refrigerator mix[a]										
Conventional	46	19	14	9	7	5	..	..	171	620
Contemporary	42	16	15	9	7	6	5	..	173	712
"L" kitchen, range mix[b]										
Conventional	42	19	12	10	9	9	..	..	162	675
Contemporary	47	14	11	10	6	7	5	..	180	805
Storage wall kitchen										
Conventional	42	19	13	7	7	6	..	5	175	668
Contemporary	40	15	13	7	7	7	4	8	182	757
Island kitchen	46	18	14.5	5.5	6	9.5	..	..	151	570

[a] Mix center between refrigerator and sink centers. [b] Mix center between sink and range centers.

Helen E. McCullough (shown at right in cover picture) is Associate Professor of Home Economics, and Mary B. Farnham (shown at left) is Research Assistant.

MACOUPIN COUNTY HEALTH STUDY

Shows how any community can cooperate for better health

PAULINE BRIMHALL, author of this report and Extension Specialist in Health Education, tells a community group about plans for conducting the Macoupin County Health Study.

WHAT can the people in a community do to identify and solve their health problems?

Back in 1955, the Illinois Department of Public Health and the Extension Service in Agriculture and Home Economics were seeking an answer to this question. At the same time, the people of Macoupin county wanted more information about the health situation in their county as a basis for better community-health planning.

From this situation, there developed the Macoupin County Health Study. Its primary purpose was to test a method of organized cooperative effort through which many agencies and groups could work together in determining the county's most serious health problems and needs.

How well the method worked in Macoupin county would indicate its probable future effectiveness in other counties. The Macoupin county study thus was a pilot project for the state.

Groundwork for the study was laid in 1955. The study actually got underway in 1956 and was completed in 1959.

The Macoupin County Health Improvement Association sponsored the study in cooperation with the county medical society, various voluntary health agencies, the public schools, rural and civic clubs, and various other community groups, as well as two divisions of the University of Illinois — the Extension Service in Agriculture and Home Economics and the Division of Services for Crippled Children.

A steering committee, composed of representatives from these groups, directed the study. The Extension Service and the Illinois Department of Public Health gave professional assistance.

Participation Important

About 400 people took active part in planning and carrying out the various phases of the study. Eventually one-sixth of the county's families, as well as many community organizations, were involved in one way or another.

The participation of so many people was a very important feature of the study. According to recent educational research, people aren't going to change their behavior on the basis of facts or information alone. Nor is even motivation enough. What is needed for any effective community action is the interested, active support and participation of the citizens.

This is in line with a fundamental objective of the Extension Service — the development of local leadership that will enable the people of a community to find satisfactory solutions to problems affecting their welfare.

Plan of Operation

A written plan. During the first year, the local steering committee, with the assistance of the state cooperating agencies, wrote out a plan of operation. When finished, it was approved by the Macoupin County Medical Society and Illinois Health Improvement Association.

Organization of health study groups. The written plan called for the organization of six study groups: (1) maternal and child health, (2) school health, (3) disease control, (4) adult health, (5) sanitation, and (6) community resources. Their main task was to gather pertinent information about the county health situation.

Each group included, in addition to a chairman and co-chairman, 20 leaders representing every part of the county. Individuals representing special federal, state, regional, or local agencies in the county took an active part in any study group that touched upon their work. The Extension Specialist in Health Education, with the help of other Extension Specialists, the Illinois Department of Public Health, and local cooperating agencies, developed guides for the group leaders.

The work of the study groups lasted a year. Among their accomplishments, the groundwork was laid for conducting the county surveys of family health and school health.

Family and school health surveys. Both surveys were conducted in the spring of 1958. The primary pur-

pose of the family health survey was to determine the health practices and problems of the families in the county, as well as the needs of the community. A secondary purpose was to involve as many people as possible in the educational process of conducting the survey. Altogether, 260 interviewers were recruited.

Questionnaires were completed on 2,048 families including 6,794 people. This comprises 15 percent of the total population in Macoupin county.

Families to be interviewed were chosen by a proportionate random method. The actual selection was made by the Chief of the Bureau of Statistics, Illinois Department of Public Health, and the Federal Extension Specialist in Health, Recreation, and Community Development.

The purposes of the school health survey were (1) to determine the adequacy and scope of the health programs in the schools and (2) to stimulate interest in making indicated improvements.

Questionnaires were prepared and distributed to all of the 50 elementary and secondary schools in the county, including six parochial schools. Of the 50 schools, 47 returned completed questionnaires.

Tabulation of data. The Bureau of Statistics, Illinois Department of Public Health, coded and tabulated the questionnaires from the family health survey. The Statistical Service Unit, University of Illinois, processed the school health survey questionnaires.

Findings

Many facts were uncovered about the health situation in the county, and a number of health problems were identified. According to the school survey, for example, more than 9,000 children need an organized school health program.

Other pressing problems are related to sanitation. Some areas, particularly small, unincorporated places, do not have adequate and safe water supplies, or garbage and sewage disposal facilities.

The major problems, however, are associated with an aging population and the chronic diseases. Since 1940, the proportion of people over 65 has increased by one-third. At least 1,150 persons of all ages, 2.6 percent of the population, have a known chronic condition serious enough to prevent them from doing full-time work or engaging in regular activities. Not all of these persons are bedfast or totally disabled.

These findings, as well as other facts learned from the study, should be helpful to physicians, voluntary health agencies, the Extension Service, schools, churches, rural and civic clubs, and many other groups.

Results

There are three steps toward the solution of community health problems — study, planning, and action. The Macoupin county study is only the first step in this process. What action results will be the true test of the project's success.

Already some action has been taken, and more is being planned. The village of Modesto, for example, has installed a public water supply system, and White City is planning to do the same. Palmyra and Modesto have begun garbage collection services.

Shortly after the school health survey was finished, the findings were presented to all teachers in the county as part of a workshop on the school health program. At present, the county Home Bureau organization is using the published report of the study as the basis for a program in health education.

The Illinois Commission on Children, White House Conference Committee, expressed a desire to integrate their findings with those of the Macoupin County Health Study, as a basis for further local planning for community improvement. A joint committee has been formed and working plans are underway.

Although it is not possible to analyze everything that happens after a community self-study of this kind, several observations can be made. The study process is a tremendous learning experience for the people in the county, as well as for state and local professional personnel. The Macoupin county study helped to create public awareness of health and community needs. There is reason to believe that the people who were most intimately involved in the project will provide the leadership in solving the major health problems in the county.

Plan now to attend the 1961
FARM AND HOME FESTIVAL

On April 6, 7, and 8, the doors of the College of Agriculture will be opened especially wide for the people of Illinois. These are the dates of the fourth annual Farm and Home Festival.

Committees representing every department of the college are now working hard to plan interesting exhibits, demonstrations, and lectures. "Foundations for the Future" is the theme of the festival, and a special effort will be made to show what today's research and education will mean tomorrow.

As at previous festivals, Saturday (April 8) will be a special day for high school students and their parents, who can learn how college training in agriculture or home economics will lay the foundation for many possible future careers.

The Town and Country Art Show and Talent Show will again be features of the festival. And other recreation is being planned as well.

Watch your newspaper for more news of the festival. Your farm and home advisers will have detailed programs sometime in March. In the meanwhile mark the dates — April 6, 7, and 8 — on your calendar, and plan a one-, two-, or three-day visit to your College of Agriculture.

RESEARCH IN BRIEF

A "Water-Bridge" Technique for Evaluating Fungicides

Evaluation of a new fungicide usually involves a series of laboratory experiments that essentially measure the growth of fungi when they are exposed to the fungicide. In one common laboratory screening method, suspensions of fungus spores are either added to a dried chemical film or incorporated in chemical suspensions or solutions. The percent of spore germination presumably determines the effectiveness of the chemical. Experience has shown, however, that a chemical may be effective in this type of test but ineffective in the field.

Under field conditions fungicides are usually applied to plants in a water medium. After the water evaporates, the chemical remains in a thin residual film on the leaf surfaces. Chemical changes may or may not occur during this transition. Aeration, radiation, and other factors may collectively or separately affect the chemical film to make it more or less fungitoxic.

Among the factors that may affect toxicity is meteorologic water (any water coming from the atmosphere, such as rain or dew). This water is necessary for the dissemination and germination of many fungus pathogens. Unless the chemical can diffuse through the meteorologic water in a fungicidal state to reach the fungus spore, the spore will germinate normally and infect the plant.

Recent experiments in the Department of Plant Pathology have tested the ability of a chemical to remain fungitoxic after diffusion through water. In these tests, the chemical is placed on one end of a glass slide and a spore suspension on the other end, about 2 inches away. The two are connected by a "water bridge."

Many chemicals which proved fungitoxic in the usual type of laboratory test did not diffuse through the water bridge in a toxic state. Such chemicals have also proven ineffective in the field. Thus, there is a direct correlation between the ability of a compound to diffuse through water from a dried film and its satisfactory performance under field conditions.

It is believed that the "water bridge" technique will greatly enhance our knowledge of a chemical in the laboratory screening program and will reduce the amount of field experimentation necessary to determine the effectiveness of a new fungicide. — *Dwight Powell*

Unusual Fat Deposits in Dairy Cattle

Abnormal characteristics that are hereditary and appear later in life, are more usual in humans than in domestic animals.

However, some hereditary conditions that develop with age have been recognized in dairy cattle. Strabismus (cross eyes), for example, is not evident until 12 months of age. The simple recessive trait of digital anomoly shows up at 2 to 4 months of age, causing lameness. The condition becomes progressively worse until, at 18 months, the animals "walk" on their knees.

Lately, another characteristic of delayed development was observed in 22 Holstein-Friesian cattle. These cattle (21 females and one male) were in two different herds.

When they were about 3½ years old, unusual growths appeared on their bodies. As the animals became older, the growths progressed extensively. The picture shows a 7-year-old cow with a growth that measured about 9 inches horizontally, 8 inches vertically, and 2 inches in depth.

Tissue sections of several growths were diagnosed as lipomas (fatty-like tumors) of the subcutaneous tissue. There were no signs of malignancy or inflammation. In two high-producing cows, the lipomas caused serious malfunctioning of the mammary system, and consequently lowered production.

From a physiological standpoint, lipomatosis invades and displaces functional tissues throughout the body. Multiple lipomatosis is not an "all or none" situation, and wide variations exist between individuals that have it.

Isolated cases of lipomas in humans are frequently found, but hereditary multiple lipomas are relatively rare. In one such case, the tumors appeared at about 35 years. Heredity-linked tumors have been observed in drosophila, mice, and rabbits.

The mode of inheritance of multiple lipomatosis in humans is generally believed to be a simple Mendelian dominant trait. The pattern of development is similar in dairy cattle. All affected dairy animals in this study had the same paternal grandsire. No common maternal ancestor was found within seven generations in either herd. This supposition about the mode of inheritance should not rule out the possibility that multiple lipomatosis could be a trait that is determined by many genes. — *J. L. Albright*

This growth on a 7-year-old cow was diagnosed as a lipoma, or fatty-like tumor.

Natural Wood Finishes Tested for Durability

Natural wood finishes, many of which contain color-in-oil pigments but allow wood grain to show through, are in increasing demand for today's modern homes. The ones available today, however, are not durable when exposed to the weather, and must be renewed each year.

Since 1957 the Department of Forestry has been conducting limited exposure tests on two finishes that showed some promise of durability. One exposure panel, 2½ x 3 feet, was faced with redwood; another with western red cedar beveled siding. Surfaces were clean and freshly sanded before the two finishes were brushed on. The left half of each panel received one coat of a synthetic resin coating containing a catalyst and an accelerator; the right half, one coat of a modified redwood stain developed by the U. S. Forest Products Laboratory. The panels were then faced toward the south, thus obtaining the severest effect of the sun.

After one year of exposure, the resin finish was chipped and peeled on both panels. The wood surface exposed by the peeling had turned light gray, indicating that it had begun to weather.

The modified redwood stain seemed in better condition. The original bright, rustic color was gone, however, and a slightly grayish color had appeared, although the discoloration was less pronounced than on the resin-finished sections of the panels. Drops of water sprinkled on the redwood-stained surface were no longer repelled as they once were, indicating that the finish needed renovating.

After two years the resin finish had failed completely. Large areas of loose resin film indicated that little or no bond had formed between the finish and the wood. The film could be broken away from the wood surface, showing that when the finish was applied it had penetrated the wood only slightly.

Although the modified redwood finish had penetrated and adhered well to the wood when it was applied, it had become thin and weathered, exposing areas of both springwood and summerwood. Failure appeared more definite on the western red cedar than on the redwood because the lighter colored cedar showed through the finish more easily.

In November, 1959, the resin finish was removed and a new finish applied. The modified redwood stain is being studied further. — *J. K. Guiher*

Natural finishes after two years of exposure. Panel at near right is faced with redwood; that at far right with western red cedar beveled siding. Resin finish is on the left half of each panel; modified redwood stain on the right half. A fresh coat of redwood stain has been applied to the right quarter of the redwood panel.

Truck Shipments of Grain by Illinois Country Elevators

Increases in truck shipments of grain by country elevators may change marketing costs and patterns and necessitate different elevator facilities. The Department of Agricultural Economics has surveyed Illinois country elevators since 1954 to determine the importance of truck shipments. (Detailed results are in Agricultural Economics Research Report 39.)

Between 1954 and the 1958-59 crop year (October 1, 1958, to September 30, 1959), truck shipments increased from 29 to 37 percent of total grain handled by elevators. During the same period, rail shipments decreased from 60 to 50 percent of grain handled, and local sales (as grain or in feed) remained constant at 11 to 12 percent.

The largest percentages of trucked grain occurred in the central part of the state, especially near the Illinois river. Truck shipments were slightly more important for corn and oats than for wheat and soybeans.

Over four-fifths of the trucked grain went to Illinois destinations in 1958-59. About half the in-state grain went to river subterminals for reshipment by barge, 17 percent to processors, and 31 percent to terminal markets. Most grain trucked out-of-state went to the southeast.

The changes noted here do not necessarily indicate a long-term trend. The future importance of truck shipments depends on future developments in transportation costs, facilities, technology, legislation, and location of markets and processing facilities. The developing St. Lawrence Seaway and the growing interstate highway system will favor the continued importance of truck and truck-barge shipments. Trucks offer fast, flexible service and are usually readily available. However, railroads are competing aggressively, and decreased freight rates may recapture much lost traffic. — *David A. Storey*

Cephalosporium Stripe of Small Grains, a "New" Disease

Cephalosporium stripe was identified in Illinois for the first time in 1960, appearing on wheat, barley, rye, and oats. First reported from Japan in 1934, this disease was found on wheat in the state of Washington in 1955.

Characteristic symptoms are long stripes on the leaves and leaf sheaths. The stripes are yellow to white on wheat, barley, and rye, and tend to be reddish on oats. Brown vascular bundles are always closely associated with the stripes. Severely infected plants are stunted and produce white heads that are either com-

pletely sterile or poorly filled with shrunken grain.

The disease is caused by a soil-borne fungus that infects the plant through the roots. The fungus produces spores in the vascular bundles, and these spores are carried up into the stems and leaves by the transpiration stream. When the spores germinate and grow, they cause plugging of the bundles. This reduces or stops the flow of water, and that part of the leaf served by the plugged bundle is killed. This results in the typical stripe symptoms.

It is not known if cephalosporium stripe is actually new in Illinois or if it has been here for some time. The disease severely reduced wheat yields on the Newton Soil Experiment Field. However, the plot where this occurred had been planted to continuous wheat, which perhaps caused a rapid build-up of the fungus and consequently more damage than would normally occur with a crop rotation. In fact, rotation may keep the disease from becoming important in Illinois. Since it has been destructive in Japan and Washington, however, we should be aware of its presence here, and try to determine its potential under our conditions.

Wheat varieties grown in the Pacific Northwest differ considerably in their reaction to this disease. Some have a fair degree of resistance, suggesting the possibility of controlling the disease through use of resistant varieties. The resistance of wheat varieties grown in Illinois is unknown. Varietal trials in an infested field were planted this fall. This planting included 50 entries from the Illinois breeding program and 300 entries from the world collection. — *J. W. Gerdemann and R. O. Weibel*

Freezing Cooked and Prepared Foods

Recent studies on freezing cooked and prepared foods had three main objectives: (1) to increase the number of cooked and prepared foods known to be suitable for home freezing; (2) to determine how method of preparation for freezing and length of freezer storage affect palatability; and (3) to learn more about the microbiology and nutritive value of a few home-frozen foods.

Many products have been prepared, frozen, and rated as to appearance, color, texture, flavor, and general acceptability. Boston brown, nut, and orange breads, fruit cake, shrimp creole, butter cream and chocolate butter cream frostings, mincemeat pie, deviled ham puffs, cheese wafers and straws, and a Swedish tea ring were considered very palatable after freezing.

Three kinds of cooky dough (peanut butter, refrigerator, and sugar) were frozen, stored for 2, 4, 6, and 8 months, and baked; while the same kinds of cookies were frozen and stored after baking. All the cookies, whether baked before or after freezing, were rated good in palatability after each storage period, except for peanut butter cookies baked after 8 months of storage. Texture and flavor had deteriorated between 6 and 8 months.

Brownies, chocolate chip cookies, and filled cookies were baked and frozen. They rated good in palatability after 2 and 4 months of storage, and fair to good after 6 and 8 months. The lowered ratings after the longer storage periods were due to undesirable changes in texture.

Chocolate cakes with chocolate butter cream frosting and plain cakes with butter cream frosting were frozen and stored for 1, 2, and 3 months. The taste panel judged both products to be of high quality after each storage period.

Other studies showed that precooked ham loaves and oven-fried chicken were less palatable than samples frozen raw, but the degree of doneness of Italian rice had little effect on its acceptability after freezer storage. Low bacterial counts were obtained for fried chicken, ham loaves, and Italian rice whether they were freshly prepared, or cooked or reheated after freezer storage. After 2 months of storage, both precooked and postcooked samples had thiamine retentions very similar to those in freshly prepared products. — *Barbara H. McGrath and Frances O. Van Duyne*

Moisture Content of Native Lumber

How much moisture or sap does green, native lumber contain? This question often is asked by those who want to ship lumber or use it in farm structures. The Department of Forestry has measured the moisture content of 600 pieces of fresh-cut dimension lumber as part of a study of the strength properties of red oak and cottonwood.

The lumber was dead-piled in a cold room and sprinkled occasionally to keep it in green condition. Moisture content was measured, however, after the pieces had been tested in static bending. The pieces probably had somewhat more moisture when they came from the sawmill. These are the measurements obtained (on an oven-dry basis):

	Oak		*Cottonwood*	
Size.......	2x4	2x8	2x4	2x8
Number...	150	150	150	150
Range, %..	38-93	39-98	24-187	22-215
Aver., %...	66	71	99	112

In interpreting the above data, these facts are significant:

1. Wood at 100 percent moisture content contains a pound of water for each pound of oven-dry wood.

At a moisture content of 215 percent, an 18-inch cottonwood 2x4 would contain 4.8 pints of water.

2. Wood does not start to shrink until it reaches about 28 percent moisture content.

3. Air-dry lumber contains about 20 percent moisture, and wood in the home contains about 10 percent. Wood to be made into furniture should be about 7 percent if you want the joints to stay tight. — *C. S. Walters.*

New Possibilities of Metabolic Control of Bull Spermatozoa

Throughout the 21 years that artificial insemination has been used commercially in breeding dairy cattle in America, control of temperature has been the chief means of reducing metabolic activity and keeping the spermatozoa fertile. Spermatozoa collected for artificial insemination may be preserved for several years by adding protective substances and then deep-freezing. With normal refrigeration temperatures of about 40° F., sperm cells remain fertile only a few days. Without refrigeration they live only a few hours.

On the other hand, spermatozoa live for several weeks in the animal at close to body temperature, which is optimum for physiological activity. Therefore, the body must contain conditions for controlling the metabolic activity and thus maintaining the fertility of sperm cells. A search for the mechanisms by which this is accomplished has been one of the continuing phases of research in the Department of Dairy Science.

We have found that the potassium (K) ion and carbon dioxide (CO_2) inhibit the metabolism of the sperm cell, while the sodium (Na) ion and oxygen (O_2) stimulate it. Experiments over the past several years have shown that the metabolism decreases as the percentage of CO_2 is increased above a minimal requirement in the gaseous atmosphere surrounding the sperm cell. This inhibition is easily reversible by decreasing the percentage of CO_2. Diluters containing carbon dioxide have increased the livability and fertility of bull spermatozoa.

Although increasing the K-ion in relation to the Na-ion has also been shown to inhibit the metabolism of spermatozoa, this effect is not yet understood and has not found practical use in the storage of sperm cells.

Research is being continued in an attempt to find the specific sites of inhibition by CO_2 and the K-ion. When the sites are found, the control of spermatozoan metabolism will be better understood. By applying this information to the composition of diluters for spermatozoa, it should be possible to maintain their life and fertilizing capacity longer than is now possible, except by the deep-freezing, cold-storage technic. These findings may have wider application in the control of metabolism in other tissues and cells. — *J. R. Lodge and G. W. Salisbury*

Antigenic Variation Among Strains of IBR Virus

A virus-caused disease, infectious bovine rhinotracheitis (IBR) has been reported in this country only in recent years. It is characterized by high fever, nasal discharge, respiratory distress, lack of appetite, and depression.

In 1956 a vaccine was developed from the tissue culture – attenuated virus and has been widely used with good results. At that time comparison of various strains of IBR virus did not reveal antigenic differences; so it appeared that a vaccine prepared with one strain would afford protection against the others.

A question about this arose, however, during investigations on shipping fever of cattle at the College of Veterinary Medicine. Two viral agents were isolated in tissue cultures and sent to two different laboratories for typing. One agent (W77, 978-82) was typed as IBR by both laboratories. The other (M2148) was reported IBR by one laboratory, but the second laboratory reported that it was probably an enterovirus.

In view of these conflicting reports, it was decided to investigate the possibility of antigenic variation among strains of IBR. The two strains isolated here, one strain from California, one from Colorado, and two from New York were used to immunize rabbits. Serum was obtained from the immunized rabbits, and the ability of each rabbit serum to neutralize the growth of each virus strain in tissue culture was measured.

None of the serums was as effective against other virus strains as it was against the strain used for inoculating the rabbit from which the serum was derived. For example, it took 6 times as much of the Colorado serum to neutralize the California strain of the virus as it took to neutralize the Colorado strain. It took 56 times as much of the California serum to neutralize the New York RT strain as to neutralize the California strain. In several instances, no heterologous neutralization was observed even with the greatest amount of serum used.

These results raise some question about the effectiveness of vaccination procedures. Obviously, if a vaccine is to be effective, it must immunize against all strains of virus. However, the results obtained with rabbits do not necessarily apply to cattle. Similar experiments should be performed with cattle to determine whether an IBR vaccine prepared from a single strain of the virus is justified. — *D. Segre*

COMING EVENTS

(A partial list of meetings scheduled at Urbana)

Jan. 24: Crop Performance Day

Jan. 25-27: Custom Spray Operators Training School

Jan. 31-Feb. 1: Agricultural Industries Forum

Feb. 1-2: Illinois Nutrition Conference

Feb. 6-Mar. 17: Winter Short Course in Agriculture and Home Economics

Mar. 14: Farm Machinery Day

Mar. 28: Illinois Swine Growers Day

FARM BUSINESS TRENDS

FARM PROSPERITY and depression have largely resulted from general national and world economic developments. The chart on this page pictures this fact.

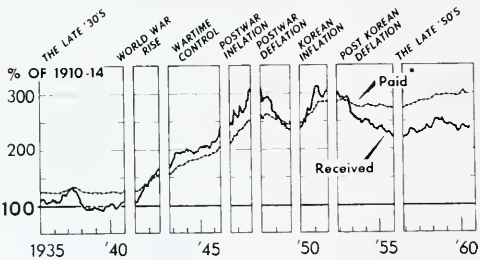
The chart is divided into eight parts, with each part representing different economic conditions such as wartime inflation and deflation. The dotted line across each segment shows the level of prices paid by farmers; the solid line, prices received.

Each line is drawn with the prices of 1910-1914 taken as 100, although only the years 1935-1960 are shown in the drawing. The base years of 1910-1914 were quite favorable for farmers. Thus, consequent favorable periods are indicated when the solid line (prices received) is near or above the dotted line (prices paid).

The late '30's. This was the last half of the nation's worst depression. Over 20 percent of the non-farm workers were unemployed. Demand for food was weak. The great drouth of the mid-'30's and a partial business recovery created a bulge in farm prices in 1936-1937.

World war rise. Big spending for military purposes stimulated the demand for farm products. Prices received by farmers went up much faster than prices paid.

Wartime control. Price controls slowed, but did not stop, the rise in prices. Prices of farm products continued high in relation to prices of things bought by farmers.



• PRICES PAID INCLUDING INTEREST, TAXES AND WAGE RATES

Prices received and prices paid by U. S. farmers, 1935-1960.

Postwar inflation. Price controls came off soon after the end of World War II. Consumers and businessmen spent wartime savings and borrowed heavily to make additional purchases. Both prices paid by farmers and prices received went up rapidly.

Postwar deflation. Prices received by farmers declined sharply as wartime demand for farm products eased, and processing and distribution expenses, including labor costs, "caught up," taking a larger share of the consumer's food dollar. The index of prices paid by farmers weakened a little, primarily because of the decline in prices of farm-produced items such as feed, feeder livestock, and seeds. Farm incomes were still good in 1948, but the cost-price squeeze was on in 1949. Most farmers, fortunately, could draw upon substantial cushions of savings.

Korean inflation. The Korean War brought more inflation in 1950 and 1951. Prices of farm products again went up faster than prices paid for farm-operating and family-living items. The cost-price squeeze was off. Farmers prospered.

Post Korean deflation. Prices received by farmers again declined, rapidly in 1952 and 1953 and more slowly in 1954 and 1955. Prices paid remained high, except for prices of the farm-produced items. This time there was no new inflation to stop the cost-price squeeze.

The late 1950's and 1960. The period of 1956-1960 was five years of relative stability for agriculture as a whole. Costs (prices paid) edged upward in 1956 and 1957, then leveled off. Prices received by farmers moved up a little in 1956-1958, trended downward in 1959 and leveled off in 1960. They averaged 80 percent of parity at the beginning of 1956, and held close to that relationship through the five years ending with 1960.

Price changes during the 25-year period point up two important facts: (1) Farmers' prices have been strongly influenced by general economic conditions, and (2) prices paid and received have come into a kind of balance in recent years. Changing this balance may be more difficult than is commonly supposed.—*L. H. Simerl*

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Spring, 1961

ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

IN THIS ISSUE

Illini Starflower, a white, daisy-type chrysanthemum of distinctive form, is one of many varieties developed by the University (page 10).

Volume 3, Number 2 UNIVERSITY OF ILLINOIS COLLEGE OF AGRICULTURE URBANA, ILLINOIS

ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

CONTENTS

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Louis B. Howard . . . . Dean and Director
Tom S. Hamilton . . . . Associate Director
Adrian Janes . . . . Station Editor
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RESEARCH IN THE DEPARTMENT OF FOOD TECHNOLOGY

is concerned with improvements in the processing and preservation of foods and also with the relation of foods to health. In recent years progress has been rapid in offering the consumer a wide variety of "convenience" foods, requiring little preparation in the home and having improved storage life combined with high quality. The increased use of these processed foods allows everyone a wider selection and is changing the national diet pattern. Research is also needed to ensure continuing improvement of public health, especially as older people are challenged by failures of body organs such as the heart.

Work is in progress on freeze-drying, a process which offers hope of preserving foods such as steaks, fruits, and vegetables, or even whole cooked meals, without refrigeration. Basic studies on the bacterial spores causing food spoilage may give clues as to how these heat-resistant forms can be destroyed without the cooking now required for canned foods. Studies on the proteins of milk should lead to improvements in ice cream and cheese and may result in a sterile milk concentrate with greater storage life. A major effort is being made to determine the role that fats and oils, particularly those from animal sources, play in atherosclerosis (the cause of many "strokes" and "heart attacks").

These investigations should not only assist the 70 billion dollar food industry (our largest) but also benefit all of us as consumers. — *R. T. Milner, Head of the Department*

Dr. Milner has held his present position since May, 1954. From 1948 to 1954 he was Director of the U. S. Department of Agriculture Northern Regional Research Laboratory, having previously been Head of the Analytical Division there. He received his Bachelor's and Master's degrees in chemistry from the University of Illinois, and his Ph.D. degree in chemistry from the University of California.

HOW IS MILK MADE?

To answer this question, dairy scientists at the University of Illinois have developed, for the first time anywhere, a method of growing mammary tissue outside the cow

Mammary cell cultures must be handled under sterile conditions to avoid contamination by microorganisms.

B. L. LARSON

THE PROPER answer to the question, "How is milk made?" depends on who is asking the question. Some will be satisfied with the answer that milk is made by the female mammal such as the cow. Others will want a more refined answer — as, for example, that milk is made by the cow in her mammary gland when certain nutrients are supplied together with the proper physiological stimulus.

The biochemist, however, is not satisfied with such definitions. He wants to know what actually goes on in the secretory cells of the mammary gland. For example, how do the genes, hormones, enzymes, etc., control the operating mechanisms within the individual cell? How are the nutrient molecules utilized for energy? How are they rearranged to form the constituents of milk?

Milk produced like cars

The synthesizing "machinery" in the secretory cells may be compared to an automobile factory. Raw materials come into various parts of the factory and are manufactured on separate production lines into the frame, motor, body, and other parts of the car. These different production lines all converge into one line where the complete car is assembled. If the production on any of the lines slows up — perhaps because there isn't enough raw material or because one worker or one machine can't work fast enough — the total output of cars will decrease.

So it is with milk production. Billions of secretory cells in the mammary gland fabricate amino acids into milk proteins, blood sugar into milk sugar, fatty acids into milk fat, and so forth. Finally, these constituents emerge together as milk. Inefficiency in any "production line" affects total production.

A study of the production lines

During past years, research with cows has determined the major environmental and feeding (raw materials) factors that influence milk production. Efficiency of production can be increased through proper feeding and management. Through selective breeding, animals can be developed that respond with even greater efficiency. However, to determine why these factors are important and to discover the more complex factors operating within the cell itself, it is necessary to delve much deeper into the problem than is possible with only outside measurable criteria.

The objective of a current research program in the Department of Dairy Science is therefore to look at and into the milk-synthesizing factory — the individual cells — and study the production lines that fabricate the constituents of milk. Various approaches to the problem have been tried. One has been to use slices or pieces of ground-up tissue and, during the short time they remain functioning, to study the various pathways of milk-constituent formation.

In the present studies a new approach has been developed. Mammary tissues are isolated from the cow and grown in a controlled laboratory environment.

Method of growing tissue

Never before had mammary tissue from any species been grown outside the animal in more than temporary laboratory cultures. A method therefore had to be devised for doing this.

In the procedure that was developed, mammary gland tissue is removed from the cow, the individual cells are loosened from the connective materials with an enzyme called collagenase, and the cells are transplanted into glass flasks. A liquid medium in these flasks supplies the nutrients that the cells would ordinarily get from the blood stream of the living animal. The cell cultures are kept in an incubator at body temperature. At intervals when the flasks become crowded with too

many growing cells, some are removed to start new daughter cultures. Some cell cultures have now been living and reproducing for more than 3 years.

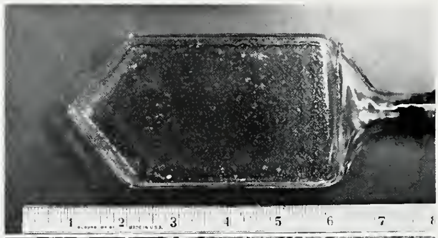
For a short time after the cells are placed in culture, they continue to make milk constituents. However, they lose this ability after a few days even though they continue to grow and organize into structures reminiscent of a cow's mammary gland. This loss in function is analogous to what other investigators have observed in cell cultures from other specialized tissues such as the kidney, heart, liver, and lung. The phenomenon is not yet understood.

The changes in the cells are similar to what happens when a cell becomes cancerous. Indeed many cell cultures that have been kept in the laboratory for some time can cause cancer in the type of animal from which they were isolated. Thus the tissue culture technique is being used extensively in cancer research. Investigators working directly on this problem are trying to find out the biochemical properties by which these cells differ from normal cells.

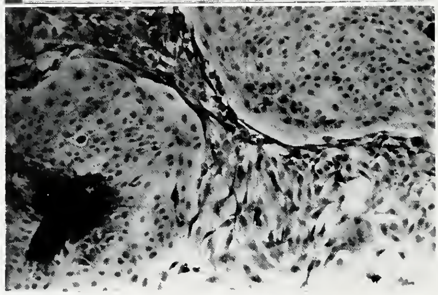
Keeping the cells active

Since the primary concern in this laboratory has been to study the synthesis of milk, efforts are being made to extend the period during which the cells continue to synthesize milk constituents. Stretching the milk-producing period will in itself help to solve the problem of defining the conditions necessary to synthesize milk in the secretory cell; for the cultures are in a controllable system isolated from the effects of the rest of the animal.

B. L. Larson, Associate Professor of Biological Chemistry in Dairy Science, has been at Illinois since 1951. Recently he was invited to lecture in France on the proteins of milk. He has also been concerned with the radioactive fallout problem.



One type of flask for growing cells is the T-flask. This one has been turned over to show the bottom layer of the cell culture. The small bright areas are piles of cells. Between these piles the cells form a single layer.



Magnified view of a layer of bovine mammary cells in culture. The small dark spots are the cell nuclei. The rounded areas at lower left and upper right are organizations of sheet-type (epithelial) cells. They are surrounded by connective tissue cells (extending from upper left to lower right). Each cell is about 1/1000 inch in diameter.

The ability to synthesize milk sugar (lactose) is apparently one of the first properties that the mammary cells lose in culture. Lactose is synthesized within the cell from blood sugar (glucose) and is composed of one molecule of glucose connected to one molecule of galactose, a sugar also formed from glucose. The metabolic pathway of lactose synthesis is still not completely understood, although it is known that several enzymatic steps are required and some of these steps have been well delineated.

One step involves an enzyme called uridinediphosphogalactose-4-epimerase (or "epimerase"), which mediates the transformation of glucose into galactose. Epimerase remains active in the cell cultures for about a week after the overall ability to synthesize lactose is lost. This indicates that epimerase activity is not the limiting step in lactose synthesis. The limiting step undoubtedly occurs at some other point as yet unknown.

β-lactoglobulin is one of several proteins in milk. Studies with radioactive tracer elements have shown that it is actually synthesized in the secretory cells from amino acids. In this it differs from some of the other milk proteins, which enter preformed from the blood stream. Apparently cell cultures synthesize β-lactoglobulin for a longer time than they synthesize lactose and even longer than they retain epimerase activity. Thus, this production line does not break down as rapidly as the one for milk sugar.

These few examples illustrate some of the properties of the mammary cells that we must delineate to understand their function. It is entirely possible, for example, that the difference between a high- and a low-producing cow may lie in the limitation set by a single enzyme in short supply somewhere on one of the metabolic pathways.

Better dairy production

It should be apparent from the discussion that the purpose of this study is not to set up huge amounts of mammary cell cultures that will produce milk commercially and thereby outmode the dairy cow. Rather, the purpose is to answer the question, "How is milk made?" on a molecular basis, so that we can more intelligently manipulate dairy cattle for man and his needs.

How much net rent from an acre of farmland?

F. J. REISS

THE NET RETURN to an acre of farmland is a useful figure. It helps appraisers to estimate value. Lenders find it useful in judging repayment capacity and soundness of loans. Farm managers use it as a measure of productivity; and landlords, as a measure of return on an investment in land.

Every year the Department of Agricultural Economics calculates net rents from records kept by co-operating farmers in the Illinois Farm Bureau Farm Management Service. The record of each tenant covers the landlord's share in the farm business as well as his own.

In the calculations, the landlord's total cash expenditures (such as for seed, fertilizer, machine work hired, taxes, repairs, fences, and new buildings) are subtracted from his cash farm income, leaving landlord's cash balance. This cash balance is then adjusted for changes in the value of landlord's inventory of feed, grain, seeds, livestock, etc., and for changes in remaining cost of the landlord's capital items from the beginning to the end of the year. The result is the landlord's net return, or net rent. It represents his return for unpaid labor, capital, and management.

Net rents reported in three ways

In the table at right, landlord's net rents are given for farms in three size groups, with four levels of soil productivity, and with two types of lease. The three size groups average 154, 254, and 460 acres.

Landlord's input of unpaid labor is almost nil on the crop-share farms, and averages less than 50 cents an acre on livestock-share farms. Thus, these net rents are essentially returns for investment in land, improvements, and operating capital, plus a return for management. Landlord's expenses did *not* include fees paid for professional management, interest, or debt payments.

Effect of soil productivity

Regardless of type of lease or size of unit, net returns to the landowner tend to decrease as one goes down the productivity scale. Because of the relationship between productivity and returns, land commands only a third of the crop as rent on soils rated 5 to 35, but half the crop on soils rating 76 to 100.

Type of lease and size of farm

Net rents per acre are generally larger on farms rented under livestock-share leases than under crop-share leases. However, the differences observed in 1954-1958 are but little more than a normal return on the extra investment of livestock-share landlords. In 1959 livestock-share landlords received lower returns than crop-share landlords because of extremely unfavorable livestock prices.

Crop-share landlords' net returns were lowest for the small farms and highest for the large farms. This is primarily because fixed costs per acre for buildings and other improvements are higher on the smaller farms. Livestock-share landlords also had higher fixed costs per acre on the smaller farms. However, since they share in the livestock returns, the higher intensity of livestock on the smaller farms more than made up for the higher costs.

The table is a good guide to net rents from improved tracts of the sizes given. It does not include returns for unimproved tracts smaller than 100 acres. Net rents on such tracts tend to be highest of all because they have no building and improvement costs to bear and the competition for land results in leases favorable to the owners.

Returns and sale value

The net returns in the table are comparatively low. If one capitalizes them at approximately the current first mortgage interest rate, the estimates of value are far below current sale prices. In 1959 the returns were only 2½ to 3 percent of land values.

These low rates resulted from the interaction of many supply and demand forces. Chiefly, people in the land market expected a continued rise in land values, and they also wanted the benefits that would be gained from larger farms.

F. J. Reiss is Associate Professor of Farm Management.

Landlord's Net Rent per Acre by Level of Soil Productivity, Size of Farm, and Type of Lease on All-Rented Farms, 1959 and 1954-1958

Soil productivity rating[a]	Under 180 acres		180-339 acres		340 acres or more	
	1959	1954-58	1959	1954-58	1959	1954-58
Crop-share and crop-share-cash leases						
Soils 100-76	$15.01	$17.18	$16.91	$20.39	$18.40	$22.03
75-56	9.62	13.88	13.24	15.62	14.09	16.43
55-36	10.56	8.73	9.91	11.20	9.27	([b])
35-5	([b])	([b])	8.62	6.27	([b])	([b])
Livestock-share leases						
Soils 100-76	9.69	25.82	13.55	23.99	15.07	23.24
75-56	10.65	21.54	12.28	20.02	11.20	16.83
55-5	.....	.....	7.78	9.99[c]	.....	.....

[a] Soil productivity indexes from 0 to 100 under a low level of management were developed by Dr. R. T. Odell, Department of Agronomy. These low level of management indexes indicate inherent soil productivity. In this study, all farms rating between 56 and 100 were in central and northern Illinois only; all rating from 5 to 55, in southern Illinois.
[b] Data not available. [c] Average of 1955-1959 and all sizes.

Early weaning of SPRING LAMBS

This may be a practical way of reducing death losses, according to results at Dixon Springs

F. C. HINDS, M. E. MANSFIELD, and J. M. LEWIS

These lambs were weaned early and fed in drylot.

High-quality spring lambs are an excellent source of supplemental income for Illinois farmers. Unfortunately, before the average producer can market most of his lambs, he is beset by losses from internal parasites, hot weather, and a decline in quality of pasture.

These stresses generally enter the picture at about the same time. In southern Illinois they usually start causing death losses in late June. However, unusually hot or dry periods in May or early June, coupled with intensive grazing of ewes and lambs on the same pasture, may precipitate this problem sooner.

During the past several years at the Dixon Springs Experiment Station, we have been seeking management systems that will allow lambs to reach market weights earlier and will prevent losses from internal parasites, heat, and declining pasture quality. We found, for example, that lambs showed no evidence of stomach worms if they did not graze with the ewes.

We also found that if lambs were consuming a creep ration, they could be successfully weaned when 9 weeks old. In view of these findings, we decided last year to study the effects of weaning at 6 weeks of age as well as at 9 weeks.

Management of lambs

All lambs were sired by Suffolk rams out of black-faced western ewes. The ewes were all of the same origin. Lambs were weaned at 6 or at 9 weeks of age regardless of weight or condition. There were two lots of lambs in each age group. It was intended that each lot contain 10 twin and 10 single lambs. but four lambs assigned to one lot died before weaning. Males were castrated and all lambs were docked at 10 to 14 days of age.

When the lambs were 5 to 6 days old, they began receiving a self-fed ration in a lighted creep. The ration, which was fed in meal form, was calculated to supply, in excess, all the nutrients that we assumed a lamb weaned at 6 weeks of age would require. It was as follows:

Ingredient	*Pounds*
Ground shelled corn	600
Ground mixed hay	250
Soybean oil meal (44%)	150
Bonemeal	10
Lime	10
Salt	5
Premix[a]	...
Total	1025

[a] 1,000,000 I.U. of Vitamin A; 200,000 I.U. of Vitamin D_3; 10 milligrams of Vitamin B_{12} activity (until average weight of 40 pounds); 10 grams Terramycin activity.

Twice during the study the lambs scoured slightly. This was corrected by increasing the antibiotic to 20 grams per 1,025 pounds of ration. Fresh water and a mineral mix of bonemeal, lime, and stock salt (1:1:4) were available at all times.

All lambs were confined in the same pole-type shed open to the south. A minimum of straw bedding was used, so that lambs' eating the straw did not become a problem.

After the lambs were weaned, the ewes were placed in a 1-acre drying-up lot and hand-fed a limited amount of mixed hay. They were all checked 3 or 4 times a week for udder problems.

Gains and feed requirements

All lambs made very satisfactory gains right after weaning and also during the entire study (Table 1). None of the lambs had any difficulty in adjusting to weaning.

As shown in Table 1, the feed required for a pound of gain was low. especially during the first 28 days after weaning. Feed requirements increased slightly but steadily as the study progressed. This trend was expected, since composition of gain has a definite influence on efficiency of gain.

Whether weaned at 6 or 9 weeks of age, twins did not perform as well as comparable single lambs (Table 2). This does not agree with previous results at this Station.

The performance of the two age groups was compared during two 21-day periods. No evidence was found that weaning lambs at 6 weeks of age retarded their ability to gain (Table 3). In fact, during both periods the lambs weaned at 6 weeks gained faster than those weaned at 9 weeks.

Marketing and grades

On June 23, all lambs that had reached 85 pounds were marketed, and on July 13, those weighing 80 pounds or more were sold. Seventeen percent more lambs were marketed from the group weaned at 9 weeks of age than from the group weaned younger. However, on the basis of live grades assigned by experienced graders, the group weaned when 6 weeks old included a higher percentage of prime lambs than the other group.

Graders at times commented on lack of a firm touch or a "mushiness" of the finish on these lambs. The same comment has been made about other early-weaned lambs raised in drylot. However, once the carcass is hung and chilled, graders can find no discernible differences in texture of finish.

Health of lambs and ewes

No strongyloid nematode eggs were found in fecal samples collected June 23 and July 13. However, tapeworm segments were occasionally found in droppings. There was no apparent relationship between time of weaning and tapeworm infestation.

Early weaning did not increase death loss. Of the 76 lambs in this study, only two died after weaning — one the day after and the other 30 days after. Both lambs had lung damage typical of that seen with pneumonia.

Both in this and in previous studies of early weaning, we have found very few spoiled udders in the ewes — no more, we believe, than under conventional systems of management. Last year we found only one bruised udder, which we treated with injections and infusions of antibiotic.

We know of no better way to reduce milk flow than to cut down the ration.

Advantages

Early weaning may have these advantages:

1. Weaning lambs early and feeding them in drylot virtually eliminates losses from internal parasites, and usually eliminates losses from predators.

2. With complete control of the feed consumed, the producer can adjust the ration to provide for maximum gains. Further, through the feed, medication can be more accurately provided and can be readily changed if necessary.

3. A more uniform group of lambs can be marketed.

4. An environment conducive to maximum gains can be provided.

5. The ease of handling and observing lambs makes it easier to locate and treat unhealthy ones.

6. A high-quality, clean, legume-grass pasture is not needed. Legumes are hard to hold in pasture mixes grazed by sheep, especially where a strict clipping or rotation program cannot be followed. Since the ewes will not be milking, they can be put on a grass pasture (fescue with or without orchard grass), which is both more durable and less costly than a legume-grass mixture.

7. Early weaning would increase the carrying capacity of a pasture.

Disadvantages

1. More grain is needed, and there may be more out-of-pocket costs for ration preparations and supplements.

2. Early weaning may damage the udders of aged ewes. However, last year we found only one-half an udder spoiled among nearly 250 ewes whose lambs had been weaned early.

3. More labor and equipment may be needed.

4. Less roughage is utilized than under other systems of management. This is an obvious disadvantage in areas where roughage is the main farm product. Further research will be done to determine the role of roughage in the rations of early-weaned lambs.

Recommendations not definite

The advantages and disadvantages listed will not, of course, appear as such under all farm conditions.

Early weaning may not be advisable on every farm. Even where it has definite advantages, we are not ready to recommend that all lambs be weaned early. We do feel, however, that early weaning will often be a practical way of handling spring lambs being raised for market. With more research, we hope we can make more definite suggestions.

F. C. Hinds is Research Associate; M. E. Mansfield, Associate Professor of Veterinary Extension and Veterinary Research; and J. M. Lewis, Assistant Professor of Agricultural Research and Acting Superintendent, Dixon Springs Experiment Station.

Table 1. — Gain and Feed Conversion of Lambs

Item measured	Weaning age[a] 6 wk.	9 wk.
	lb.	lb.
Av. initial weight	30.0	40.6
First 28 days		
Av. daily gain	0.501	0.584
Feed per lb. gain	3.30	3.30
Overall performance		
Av. daily gain	0.476	0.486
Feed per lb. gain	4.74	5.38

[a] Data are averages of replicate lots at both weaning ages.

Table 2. — Gains of Twins and Single Lambs

Item measured	Singles, weaned at— 6 wk.	9 wk.	Twins, weaned at— 6 wk.	9 wk.
	pounds			
Weaning wt.	33.4	45.9	26.6	34.3
ADG[a], first 28 days	0.526	0.664	0.475	0.507
ADG[a], entire study	0.502	0.511	0.446	0.457

[a] ADG = average daily gain.

Table 3. — Gain and Feed Conversion During Two 21-Day Periods

Item measured	Lambs weaned at— 6 wk.	9 wk.
April 29 — May 20[a]		
Av. age at time of comparison, days	80	80
Av. initial weight, lb.		
Single lambs	51.7	54.6
Twins	45.0	38.3
Average	48.5	46.5
Av. daily gain, lb.		
Single lambs	0.595	0.528
Twins	0.523	0.462
Average	0.561	0.495
Feed per lb. gain, lb.	4.57	4.26
May 20 — June 10[b]		
Av. age at time of comparison, days	92	92[c]
Av. initial weight, lb.		
Single lambs	55.7	65.6
Twins	46.5	46.0
Average	51.1	57.8
Av. daily gain, lb.		
Single lambs	0.467	0.410
Twins	0.362	0.371
Average	0.414	0.395
Feed per lb. gain, lb.	4.16	6.19

[a] First replicate.
[b] Second replicate.
[c] Four twins died before weaning.

LEPTOSPIROSIS
in
Cattle and Swine

L. E. HANSON, author of this article, is Associate Professor of Veterinary Pathology and Veterinary Research. He has been at the University of Illinois since 1950, having come here from Michigan.

Will leptospirosis permanently damage my herd? This frequently asked question is difficult to answer. Leptospirosis has been recognized as an important disease of cattle and swine in the United States only since the mid 1940's. In the past it was confused with such diseases as brucellosis and vibriosis, which produce similar signs. Recognition was further delayed by the high percentage of cases in which significant signs are absent.

What is the cause?

Leptospirosis is caused by a large group of closely related bacteria called leptospires. Of these, *Leptospira pomona* is responsible for most infections of cattle and swine in the United States. Two other species, *L. sejroe* and *L. grippotyphosa*, are apparently of some significance also in Illinois.

In 1960, 19,400 bovine sera were submitted to the State Diagnostic Laboratory in Urbana for leptospirosis tests. Nine percent of these sera contained *L. pomona* antibodies. Of the sera negative for *L. pomona* antibodies, 884 were from cattle which had case histories suggestive of leptospirosis, and these were also tested against the antigen of five additional species of leptospires. The reactor rate was significant for only two species, *L. sejroe* and *L. grippotyphosa*.

The same year 18,700 swine sera were tested for leptospiral antibodies. A reactor rate of 3.7 percent for *L. pomona* was demonstrated. A further test against five additional species was made in 240 sera. Antibodies for only one of the antigens, *L. grippotyphosa*, were detected in a significant number of sera.

How did my animals get leptospirosis?

Urine voided by infected animals is the primary source of leptospires. The exact mode of transmission is often difficult to determine without a thorough investigation of the individual situation. Leptospires may enter an animal by several routes and the organisms have a wide host range. They can also live for extended periods in urine-contaminated ponds, streams, or marshy areas.

Usually leptospires enter an animal through breaks in the skin as the animal is wading in ponds or walking on marshy ground contaminated wtih infected urine. Less frequently, mucous membranes may be invaded by leptospires from contaminated water or infected fetal membranes. Occasionally aerosols created by splashed urine may contaminate the delicate membranes of the eye, which can be easily infected. The chart on the next page illustrates the primary modes of transmission.

Swine appear to be the major reservoir host of *L. pomona* in the United States. There are a number of reasons why this is true. Swine are easily infected, and when infected they release large numbers of organisms in the urine for several months up to a year. Also many infected adult swine do not show signs of the disease, so the owner doesn't segregate these animals. Another important reason in the midwest is that on many farms swine and cattle are pastured together or confined in the same feedlots.

Cattle may also play a major role in transmitting the organisms. Although cattle have a shorter carrier stage than swine and also void fewer organisms in the urine, the large number of cattle on some farms often makes transmission easy.

Wild animals have been found infected, but the importance of these infections has not been determined. Several extensive bacteriologic and serologic surveys have been conducted in various areas of the United States to determine the extent of leptospirosis in the wild animals. *L. pomona* has been isolated from raccoons, opposums, and skunks. Many other species, including *L. grippotyphosa, L. canicola, L. hyos*, and *L. icterohaemorrhagiae*, have also been isolated. This indicates a possible source of strains other than *L. pomona*, and may also explain some spontaneous outbreaks of leptospirosis in closed herds.

L. ballum is the only strain that has been isolated from wild animals in Illinois. Of large numbers of Illinois deer sera obtained during the last three deer seasons, about 10 percent showed *L. pomona* antibodies in serological tests; and 10 percent, *L. grippotyphosa* antibodies. However, repeated attempts to isolate leptospires from the kidney tissue of these deer have been unsuccessful.

What are the signs?

Once the bacteria pass the skin barrier, they multiply rapidly in the host tissues. Leptospires can be de-

tected in the blood stream 2 to 6 days after exposure. While the bacteria are in the blood the animal will have a fever and will frequently exhibit other signs of the disease.

Often cattle develop a soft mastitis and thick clots appear in their milk. Both cattle and swine may become anemic and excrete urine stained red by pigments released from destroyed red blood cells.

Pregnant cattle and swine are particularly susceptible to *L. pomona,* with abortion the most obvious sign of the disease. Abortion is apparently due to either direct invasion of the uterus by leptospires or to a toxemia produced in the dam by the infection. Despite the frequency of abortion, the disease does not appear to cause sterility problems in later pregnancies. The records of twelve large Illinois herds have indicated no significant differences in breeding efficiencies of the cattle before and after leptospirosis.

Kidneys and liver are the organs most severely affected, and extensive damage may cause death in calves and small pigs. Adult animals seldom die from the disease.

Following the early stages of the infection, the leptospires usually localize in the kidney tubules, where they may persist for varying periods of time. Swine may harbor the bacteria for as long as a year, releasing large numbers of leptospires in the urine. In cattle, the carrier stage is seldom longer than 3 months.

How is the disease diagnosed?

Like most diseases, leptospirosis can best be diagnosed by correlating the clinical signs with serologic and bacteriologic tests. Animals usually develop significant levels of detectable antibodies 6 to 8 days after becoming infected. A number of serologic tests have been developed. A plate agglutination test, which is simple to perform, is conducted by many veterinarians and diagnostic laboratories. In addition, the agglutination-lysis test, which is more accurate but also more time-consuming, is done by some of the diagnostic laboratories.

The deficiency of the serologic tests is that they only indicate whether an animal has or has not had the disease at some time. As the sera of most animals remain positive for one to several years after they have contracted the disease, the serologic test results must be correlated with the herd history.

Leptospires can often be isolated from tissues of aborted swine fetuses, but seldom from aborted bovine fetuses. The organisms are also easier to isolate from swine urine than from cattle urine.

Can leptospirosis be prevented?

Yes, if animals can be protected from exposure to leptospires. Although it is difficult to avoid all types of exposure, such as contact with animals, the most important sources of infection can be avoided.

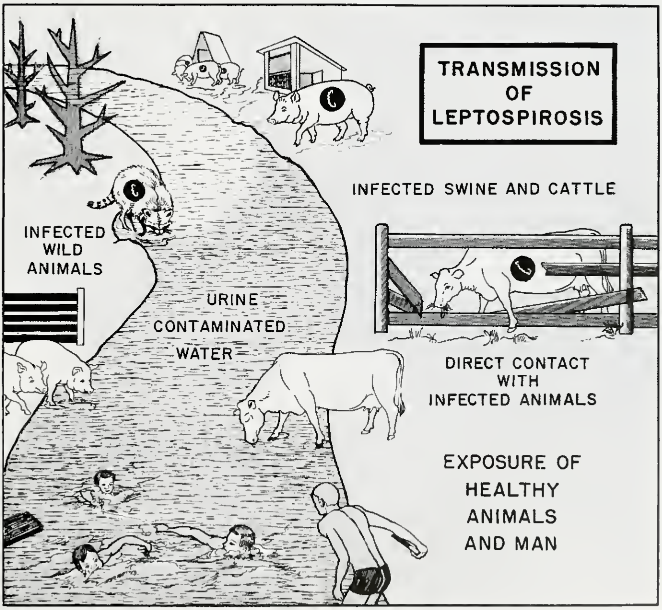
Because surface water is the medium which carries most infections, fencing animals away from suspected streams or ponds will aid in control. Susceptible animals should not be turned onto pastures receiving drainage from land that is grazed by infected animals.

New animals should be tested for leptospirosis before being introduced into a herd. Introduction of an infected sire or show animal is likely to activate an infection.

Vaccination has become common in recent years. According to experimental studies in the College of Veterinary Medicine, the present bacterins provide definite but limited protection. Although vaccinated animals may become infected, such signs as abortion usually do not occur. For best results vaccination should be instituted before infection takes place and should be accompanied by sound sanitary practices.

What about human health?

Human beings can get leptospirosis. Those who work with animals or raw meat are most likely to become infected. People can also get the disease by swimming in water contaminated with the urine of infected animals.



Illini Chrysanthemums

J. R. CULBERT

ILLINI CHRYSANTHEMUMS represent the University of Illinois wherever chrysanthemums are grown. From Florida to California, from Sweden to Japan, growers are flowering varieties bred and developed at the University. Since 1919, 106 varieties have been introduced to the florist industry.

The story of Illini chrysanthemums started in 1908. At the persuasion of J. C. Blair, then Head of the Department of Horticulture, Herman B. Dorner left his new job as botany instructor at Wabash College, Indiana, and came to Illinois to develop a teaching and research program in floriculture.

Chrysanthemums were dear to the heart of the new professor, for his father was a famous breeder and grower of these flowers. What was more natural than for Professor Dorner to launch a breeding program of his own?

The autumn of 1909 saw the first chrysanthemum seedlings in bloom at the University. After 10 years of trials, 24 new varieties were released, including Maple Leaf, Coed, Golden Star, and Illini. The name "Illini" was to be used later as a prefix identifying all chrysanthemums developed by the University of Illinois. Years after Golden Star was introduced, it was to appear as one of the parents of Illini Snowdrift, the most famous of all Illini chrysanthemums.

In laying the foundation for Illini chrysanthemums, Professor Dorner was aided by Stanley W. Hall, who joined him in 1917.

Improved commercial varieties

From the very start of the breeding program, the aim was to create varieties useful to the commercial grower. No attempt was made to develop chrysanthemums for the home garden, although many have found a place in warm southern gardens.

In 1908 the chrysanthemum industry was still close to its infancy. As improved varieties came on the market, production expanded. New and distinctive flower forms, different colors, variation in flower size, and increased vigor and productiveness were among the improvements sought.

The search for these improvements has continued through the years. Illini Snowdrift, a white variety introduced in 1950, had a brand new feathery form which gave a fresh impetus to the use of chrysanthemums in corsages, wedding bouquets, and other arrangements calling for daintiness. Illini Goldrift, of similar form but yellow in color, came out in 1959. Illini Starflower, available since 1955, brought a white flower of great distinction to the market and became a favorite of flower arrangers.

Extending the blooming period

Another aim of the breeding program was to extend the natural blooming period. Most greenhouse chrysanthemums flower naturally from late October through mid-December. No one variety could be flowered during the entire period. A constant supply of flowers during these months was provided by a succession of varieties with different natural flowering dates. For example, a grower who wanted a constant supply of yellow pompons from November 5 through December 5 might choose these varieties: Illini Goldcup, natural bloom date, November 5; Illini Yellow Igloo — November 10; Illini Brave — November 15; Illini Sunspot — November 20; Illini Gold — November 25; and Illini Wampum — December 5.

After many attempts to develop varieties that would extend the natural flowering period, two were developed and released to the florist industry. These were Illini Bright Eyes, which flowers December 20; and Illini Snowbound, which flowers January 5. Illini Snowbound still has the latest natural flowering date of any chrysanthemum on the market.

Year-round mums

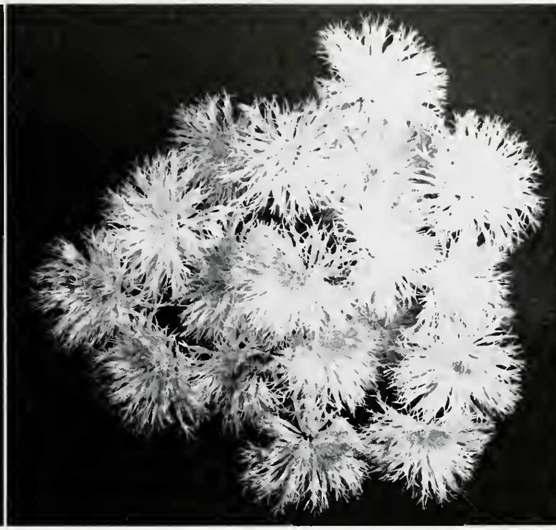
Meanwhile, profound changes were taking place in the culture of chrysanthemums. Research had shown that many plants flower at a certain time because of their response to day length. The chrysanthemum was found to be a short-day plant. A certain variety, for example, might set its buds regularly on September 1 because of the shortening day length, and take from September 1 to November 5 to reach maturity. Year after year, then it would flower on November 5. By artificially shortening the day beginning on August 1, the flowering date could be changed to October 5.

Later it was found that flowering could be prevented by lighting the plants in the middle of every night before the buds formed. When it was discovered that a night temperature of 60° was necessary for bud formation all the tools for controlled flowering were at hand, and a given variety of chrysanthemum could be flowered on any day desired.

Thus modern scientific research made it possible to produce chrysanthemums every day in the year by proper manipulation of day length and temperature. Within a few years the impact of these discoveries revolutionized chrysanthemum culture. Greenhouse operators began to flower chrysanthemums around the year on controlled schedules. Northern growers could flower chrysanthemums on schedule out of doors during the summer. Before long, Florida and California growers were flowering chrysanthemums out of doors in the winter and shipping the flowers all over the country.

Most of the varieties that had been bred and developed over the years were not suitable for year-round or out-of-season culture. The breeding program thus had to be rapidly changed to provide varieties that were good not only in their natural season but also at other times of the year.

ini Igloo — a white pompon with many uses.



Illini Snowdrift — adds daintiness to arrangements.

Fortunately, there were enough .rieties with good year-round flower- g ability that commercial growers uld make a start. Illini Igloo was ıe of the best, soon becoming a andard variety both in the north and Florida, where it was especially od.

me major changes

With the development of year-round ırieties, a major change has occurred the economy of chrysanthemum cul- re. This, in turn, has forced more ıanges in the breeding program.

The bright winter sun in Florida ıables the grower there to produce :tter and less costly pompons than ose grown in the north. To meet the mpetition from the south, the north- n grower has drastically reduced the ımber of pompons grown during e winter and has concentrated on the rge-flowered or football type of chrys- ıthemum. This type cannot be own successfully in Florida, because e flowers are damaged when grown ıtdoors.

Also, the northern grower is switch- g to the production of potted plants. ot chrysanthemums are the most important flowering pot plants grown throughout the year. High transportation costs make it difficult for the southern grower to produce and market pot plants in competition with the northern grower, who is near the market.

Because of these developments, the Illini breeding program for the past several years has been aimed at producing large-flowered varieties and varieties suitable for pot plants. Another important objective is to develop varieties that can be grown at lower winter temperatures, thus enabling the Illinois grower to cut costs.

Basic aim unchanged

The story of Illini chrysanthemums began in 1908. Fifty-three years later the chrysanthemum is the number one year-round cut flower and pot plant instead of an important flower for the autumn only. Some breeding objectives have drastically changed, but the basic objective as laid down by Herman Dorner and Stanley Hall is the same: to create chrysanthemum varieties useful to the commercial flower grower and better than those already on the market.

Illini Snowdrift is striking as a potted plant as well as a cut flower. Holding these blooms is author J. R. Culbert, Associate Professor of Floriculture, who has been at Illinois since 1946. From September, 1959, to July, 1960, he was on leave from the University to serve as technical adviser on chrysanthemum propagation and culture for the Frampton Nurseries, England.

AERIAL PHOTOGRAPHY Depends on REFLECTED LIGHT

C. E. OLSON, JR.

FORESTERS, soil surveyors, and farm planners have been using aerial photographs for years. The value of an aerial photograph depends on our ability to use the information that it contains. This ability, however, is limited by our understanding of the sensing process involved.

To make best use of aerial photos, we need to understand what is actually being sensed, how this quantity gets to the sensor, and how the sensor records what it does. The camera seems like a simple and well-understood sensor. But is it?

The journey of light

Light — usually originating at the sun — is the energy quantity that the camera senses. After light leaves the sun it must pass through a maze of debris in space before it strikes an object on earth. This debris includes water, dust, meteor fragments, and other substances that influence the quantity and quality of light reaching the earth.

When light strikes an object on earth, it may pass through an object like glass, be reflected by mirror-like objects, or be absorbed by such very dark objects as soot and asphalt. Many objects transmit part, reflect part, and absorb part of the light that strikes them.

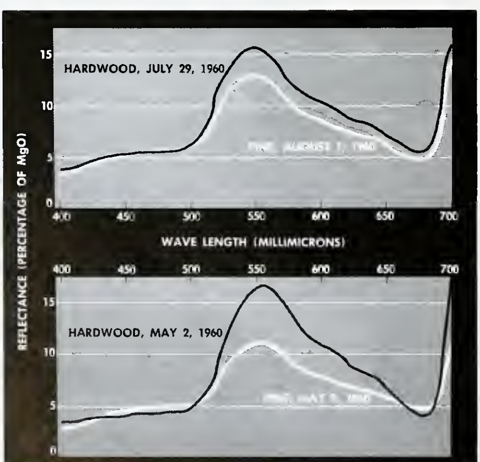
Light reflected into space may eventually reach a camera, but first it must pass through the maze of spatial debris between the reflecting object and the camera. After light reaches the camera, it may pass through a selective filter, which absorbs (or subtracts) certain colors of light. It then passes through a lens system before striking the photosensitive emulsion on the film, where light intensity is recorded. The developing process makes this record visible to the eye.

Considered this way, the photographic sensing process is not quite so simple. When one realizes how little we know about the nature of light, about light reflectance from different objects, and about the photographic sensing process, it seems amazing that we can do so much with aerial photographs. At the same time we may wonder if we actually use all the information that the photograph records.

Light reflectance from trees

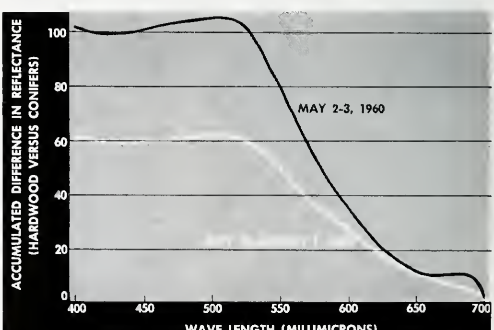
To learn more about the photographic sensing process, studies of light reflectance from forest vegetation are being conducted by the Department of Forestry in cooperation with the Department of Botany. During the 1960 growing season, light reflectance from several species of trees was measured weekly with a recording spectrophotometer, which produces a continuous record of percentage and wave length of light reflected. Wave length was measured in millimicrons — units that are only 0.000000039 inch long.

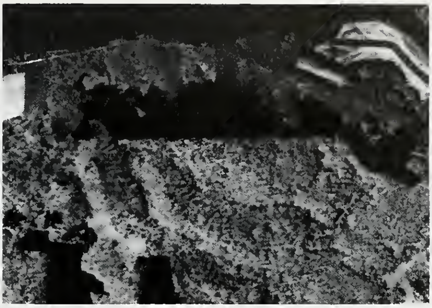
Among the species studied were basswood (*Tilia americana*), cottonwood (*Populus deltoides*), silver maple (*Acer saccharinum*), yellow



At left, average light reflectance by wave length for foliage of 16 hardwood and 8 pine trees near Urbana, in May and in July-August, 1960. (Fig. 1)

Below, accumulated difference in light reflected from hardwood and pine foliage at two different times in the 1960 growing season. (Fig. 2)





Photograph at far left was taken of the Sinnissippi Forest, near Oregon, Illinois, in September, 1951. A panchromatic emulsion and medium yellow (minus blue) filter were used. Hardwoods and pines show little variation. (Fig. 3)

The same area was photographed in May, 1958, with the same type of film and filter (near left). At this time of year pines and hardwoods contrast sharply. (Fig. 4)

poplar (*Liriodendron tulipifera*), red pine (*Pinus resinosa*), and Scotch pine (*Pinus sylvestris*).

Although data have not yet been completely analyzed, some definite trends are apparent. Percent reflectance was low in the blue end of the spectrum, where wave lengths are short (400 to 500 millimicrons). As wave length increased, percent reflectance rose rapidly, reaching its maximum in the green band of the spectrum where wave length is about 550 millimicrons. Percent reflectance then decreased as color changed from green, through yellow to red, and as wave length increased to 680 millimicrons. After this point, wave length entered the near-infrared portion of the spectrum, and percent reflectance again rose rapidly.

Differences between species

While this pattern was characteristic of all green foliage, some species reflected more light than others. Also, different amounts of light were reflected at different times. In Figure 1, average reflectance values of the hardwood species are compared with those of the pines. Three general observations seem significant:

1. Hardwood foliage reflected more visible light than pine foliage, both in early May and in late July.

2. Hardwood foliage reflected less visible light in late July than in early May.

3. Pine foliage reflected more visible light in late July (actually measured August 1) than in early May.

As the hardwoods became darker (reflected less light), the pines became lighter (reflected more light), and the difference between them became less. This is shown graphically in Figure 2, where the accumulated difference in reflectance (starting at 700 and working toward 400 millimicrons) is plotted over wave length. The curve for early May is much higher than the curve for late July.

Preliminary analysis has been made of data for the last half of the growing season. It indicates that, until the fall color change begins, the accumulated difference relationship strongly resembles the one for late July. After the foliage starts changing color, the accumulated difference rises sharply.

The curves in Figure 2 are particularly significant to the forester. For the higher the curve, the more likely that an aerial photograph on a panchromatic emulsion will record hardwoods and pines in different tones, or shades of gray. In other words, the likelihood that pines will photograph noticeably darker than hardwoods is much greater in early May than in late July. In the fall, differences between hardwoods and pines may be obscured, for some hardwood species change color much earlier than others and stands can show highly variable reflectance patterns.

The significance of these differences in reflectance is illustrated in Figures 3 and 4. The photograph in Figure 3 was taken in September, before many hardwoods had begun to change color and while hardwood and pine foliage was still fairly uniform in tone. In the other photograph, which was taken in May, the dark-toned pine stands contrast sharply with light-toned hardwood stands.

The lack of a tonal difference between hardwoods and pines in the September photograph does not mean that a difference in reflectance did not exist. It means, only, that the difference was not great enough to create a visually detectable difference in the photograph. In May the difference was great enough to create distinctly different tones.

Useful in many fields

As we learn more about light reflectance from tree foliage, aerial photographs will become more useful to foresters. Expansion of this research to include light reflectance from soils, crops, non-crop field vegetation, and other substances is planned, and should increase the usefulness of aerial photography in many other fields.

C. E. Olsan, Assistant Professor of Forestry, came to the University in 1956 after 3 years in the U. S. Navy. He is chairman of the University of Illinois Committee on Aerial Photography.

The research described in this paper was financed in part by the Office of Naval Research as Project NR-387 025.

Brittle root of horseradish

H. H. THORNBERRY

GROWERS OF HORSERADISH around East St. Louis dread brittle root more than any other plant disease. Every year it causes serious crop losses in that area, although it rarely occurs in Cook county, the other major horseradish-producing area in the state.

Before brittle root can be effectively controlled, we must know the cause. The disorder has been attributed to the virus that causes curly-top disease in sugarbeets and many other plants, but we do not have satisfactory evidence for this theory. Conclusive evidence, either for or against the theory, is being sought in the virology laboratory of the Department of Plant Pathology, with the cooperation of workers in the Federal Sugarbeet Laboratory at Salinas, California.

Illinois horseradish production

Illinois is one of the leading states — if not the leading state — in horseradish production. About 85 percent of the acreage is in the East St. Louis area. The rest is in Cook and Peoria counties. Production averages 2,000 to 6,000 pounds an acre in favorable years.

Decline of "set" roots

The source of "set" roots (lateral roots used for propagation of plants) is an important factor in production. Usually set roots that are locally grown are best adapted to an area, tending to improve with each generation. In the East St. Louis area, however, locally grown set roots of horseradish have been declining in vigor, possibly because of brittle root. This decline soon offsets the advantages of adaptation to the local climate and soil, and after 3 or 4 years of local perpetuation the set roots become too unthrifty for profitable production. Growers in the East St. Louis area therefore have to obtain set roots from northern areas about every third year.

Source of "set" roots affects stand and vigor of horseradish. Plants at right of picture are from sets of plants grown in Wisconsin in 1953; those in left part of picture are from sets of plants grown in Wisconsin in 1952 and grown locally in 1953. This photograph was taken near East St. Louis in 1954. (Fig. 1)

In some years the contrast between plants from northern-grown sets and those from locally grown sets is striking (Fig. 1).

Control measures

Brittle root was especially serious in 1953 (Fig. 2). After the heavy losses that year horseradish growers have been spraying their crops with DDT on the assumption that the disease is caused by the curly-top virus and that DDT controls the leafhopper vector, *Circulifer tenellus* (Baker), which carries this virus.

Although brittle root has been less severe since 1953, we are not sure whether this is due to the DDT or to less favorable climatic conditions for the disease. It will require another year, like 1953, that is favorable for the disease, before the effectiveness of DDT sprays can be fully assessed. (The work with DDT is being supervised by entomologists in the Illinois State Natural History Survey.)

Seeking the cause

In the meanwhile we are working to determine the cause of the disease. The curly-top virus was found in sugarbeet leafhoppers collected from horseradish fields in 1953. This finding, however, is not evidence that the virus causes brittle root.

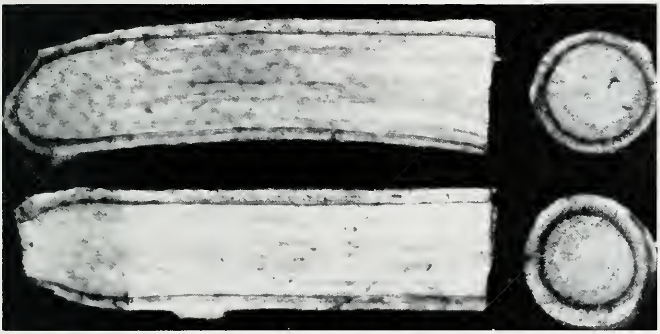
The curly-top virus has not as yet been obtained from horseradish plants showing typical symptoms of the brittle-root disease. Nor have typical symptoms been induced in healthy plants by introducing a colony of virus-bearing leafhoppers to feed on them for a period of time. Tests on horseradish have been negative even though the leafhoppers transmitted the virus to sugarbeets before and after their colonization on horseradish.

These negative results are forcing us to a more roundabout route of seeking evidence for the curly-top virus in horseradish. This involves the use of purified preparations obtained from sugarbeets infected with the virus.

These preparations have been obtained by a method known as differential ultracentrifugation. In this method, the expressed juice from diseased sugarbeet leaves is first centrifuged at 20,000 AFTG (average force times gravity) for 10 minutes to remove particles larger than viruses. The clarified liquid is then centrifuged at 50,000 AFTG for 4

H. H. Thornberry, Professor of Plant Pathology, has been at Illinois since 1928. This summer he is going to Europe to investigate the possibility of organizing an international center for technical information on plant virus diseases.

Brittle root destroyed nearly all the plants in the field at left. In field shown above, some plants were destroyed while others remained healthy. Both fields are in the East St. Louis area and were photographed in 1953. (Fig. 2)



Horseradish roots infected with brittle root characteristically have dark brown to almost black streaks. Such roots are very brittle and will snap instead of bending as healthy horseradish roots do. *Photograph by Kadow and Anderson, 1940.* (Fig. 3)

Electron micrograph of virus-like particles in samples of infectious purified preparations from curly-top sugarbeet plants. Long rods are 20 to 30 millimicrons (mμ) in diameter and 150 to 200 mμ in length. Spheres or short rods are 15 to 30 mμ long. (Fig. 4)

hours or 100,000 AFTG for 2 hours. This force is sufficient to sediment particles the size of plant viruses but not smaller particles (Fig. 4).

We have not yet determined just which type of virus-sized particle is infectious. However, it does seem reasonable that some of the particles, at least, are associated with the infectiousness of the preparation. Any substance in the original juice that could be carried through the procedure would be diluted to about 1:100,000,000. Even the most infectious plant juices — for example, those containing tobacco mosaic virus — become noninfectious before this dilution point is reached.

At present a new procedure is being tried for purifying the curly-top virus. This procedure (charcoal-sodium sulfite-buffer-differential-sedimentation method) was originally developed at Illinois to purify another virus. It has promise because it requires little time and provides reasonably clean preparations with one sedimentation. The buffers presumably stabilize the virus and protect it against inactivators in the original juice. Preparations by this method are being examined in the electron microscope and assayed for infectious virus in the laboratory at Salinas, California.

With the purified preparations and serological techniques, we plan to test the juice of brittle-root plants for curly-top virus. The serological techniques will involve injecting rabbits with the purified preparation so that antibodies against the virus will be produced in the rabbits' blood. The antibodies from the rabbits will then be added to the juice from the horseradish. It is expected that the behavior of the antibodies will tell us whether or not the curly-top virus is in the horseradish juice.

Antiserum prepared for these serological tests will also be useful in diagnosing curly-top infections in other crop plants or in weeds suspected as reservoirs of the virus.

A GROWING JOB

J. B. CLAAR

The Cooperative Extension Service faces new problems in a changing world

It is very appropriate to write an article about the Cooperative Extension Service in a publication called "Illinois Research." For through the years research at the University of Illinois has provided information for Extension programs.

The challenge to Extension

As described in the Smith-Lever act of 1914, the job of the Cooperative Extension Service is to "extend to the people of the United States practical information on agriculture, home economics, and subjects relating thereto." The Extension Service is financed by federal, state, and local funds and is both the educational arm of the U. S. Department of Agriculture and an off-campus representative of the University of Illinois.

Although the number of Illinois farm families has somewhat declined in line with the national trend, Cooperative Extension has received increasing demands for its services.

Actually, of course, agriculture is a growth industry in the state with increasing capital inputs, higher output, and much greater demands on the management capacity of farm operators. As farms have specialized and have increased in size, farmers have required more and more technical information. It is becoming less possible to provide this information in isolated pieces; instead it is necessary to relate each bit of information to an entire system of production. Handling this highly technical information has placed an added burden on state specialists and has necessitated extensive in-service training programs for county staff. This same story could be repeated in the area of home economics.

Today a great many commercial and other sources share with Extension the task of disseminating information. To keep these sources fully informed, Extension has increased its work with dealers and others who provide services to farm families.

Partly because of the many informational sources, but mostly because of the fast-changing scene and growing businesses, Extension has provided extensive teaching programs on the principles of farm and home management and their application. Through such programs, Extension can help families to objectively weigh information from many sources, fit it into their farms and homes in a systematic way, and make the adjustments needed today. This service seems to be a unique function of Cooperative Extension.

Expanded programs and clienteles

Extension has received increased demands for educational programs about taxation, zoning, and other subjects related to public affairs. Moreover, many areas of the state have become much interested in the economic and social development of their communities, and have asked Extension to help them with information and leadership. Extension has added two extra people to give this help in southern Illinois.

Marketing has also required more attention. This has included work with farmers and marketing firms to help them reduce costs, and with consumers to help them make more informed choices.

These and other Extension programs directly benefit people in town as well as on the farm. Recognizing this, urban people have been requesting more assistance and information from Extension.

Youth work continues to be an important Extension job. The program has been putting more emphasis on such subjects as careers, while continuing the time-proven "learn by doing" projects.

Program development

The preceding list of some of the program areas illustrates the type of work being done and the problems that Extension faces. Many of the program areas could justifiably command all the resources of Extension. The problem of placing priorities is a difficult one. Which areas are important enough to merit staff time; which must be foregone?

Through program planning at the county level, we hope to involve more people of the state in making these decisions. It is important, however, that the decisions be made by people who see the total job and have analyzed it carefully. As a beginning point, the state staff is now reviewing present programs.

Planning for the future

The Cooperative Extension Service in Illinois has received strong financial aid at the local level from Farm and Home Bureaus. Their grants to the University now amount to over $1,500,000 a year. It is expected that the University will continue to receive substantial voluntary financial grants for Extension work. In addition, since cities are requesting educational help from Extension, the possibility of support through local taxes in a few large urban areas should be studied.

Illinois people can justly take pride in the Extension program which they have helped to develop and carry on through the years. Cooperative Extension in this and other states has achieved world-wide acclaim for the job it has done in making information from research a vital force in people's lives. With respect for the great accomplishments of the past, we must carefully analyze the present and plan for the future.

J. B. Claar is Associate Director of the Cooperative Extension Service.

RESEARCH IN BRIEF

Drastic Changes in Count and Distribution of Population

The final official population count of the state as of April 1, 1960, was 10,081,758. This is 1,368,982, or 15.7 percent, more people than in 1950; and is the largest numerical increase ever recorded during a 10-year period since the first official population census of Illinois in 1820.

The tremendous increase in the state's population resulted from the continuing high birth rate. Between 1950 and 1960, 2,193,271 babies were born to Illinois residents. At the same time, 968,695 residents died, resulting in a natural increase of 1,228,576, or 89.5 percent of the total increase. The remaining increase of 144,406 was due to a net migration into the state.

Despite this dramatic rise in population, 51 of the state's 102 counties had fewer inhabitants in 1960 than in 1950. Particularly significant is that 44 of the 51 counties had also lost population between 1940 and 1950.

Most significant trend in the differential growth of the state's population was the continued concentration of people in the 15 counties under the influence of the largest cities. Champaign, Cook, DuPage, Kane, Lake, McHenry, Macon, Madison, Peoria, Rock Island, St. Clair, Sangamon, Tazewell, Will, and Winnebago counties accounted for 1,315,870, or 96.1 percent, of the total increase, and now contain 76.9 percent of Illinois' total population. The same counties accounted for 94.5 percent of the increase between 1940 and 1950. There were 958 persons per square mile in these 15 metropolitan counties in 1960, 658 in 1950, 573 in 1940, and 553 in 1930.

Urbanization of the state's population continued, with 80.7 percent classified as urban in 1960, and 19.3 percent as rural. In the last decade, 70 counties lost rural population while only 32 gained. The rural losses were in the most agricultural counties of the state; rural gains were either in the counties that contained the largest cities or in contiguous counties.

The growth and redistribution of population pose many socio-economic problems for agricultural and nonagricultural leadership in the state. — *C. L. Folse*

Penta-Gel Simplifies Treatment of Fence Posts

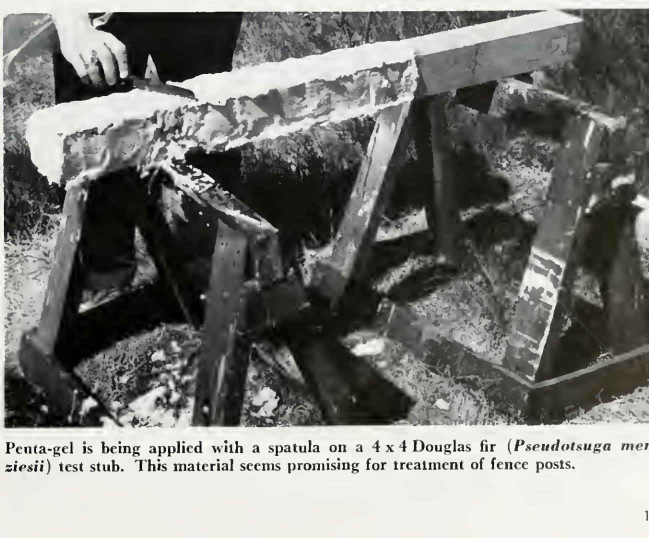
Preservatives for treating fence posts have been available for some time; yet, of the 26 million fence posts used annually in Illinois, less than 10 percent are treated. This is probably because ready-treated posts have a high initial cost, and home treatment requires special auxiliary equipment.

One answer to this problem may be a penta-gel preservative under test by the Department of Forestry. (The penta-gel was supplied by the Wood Treating Chemicals Company, St. Louis.) This material contains 10 percent pentachlorophenol in a petroleum solvent, plus special emulsifiers and water. It has been thickened enough that it can be applied in heavy coatings from ¼ to 1 inch.

Application is simple. The gel can be easily spread with a mason's trowel, or some other implement, from the bottom of the post to a distance 6 inches above the ground line.

Once the material is applied to the wood, it tends to form an outer crust. Beneath this layer the water coating on the oil particles breaks down on contact with the wood, allowing the pentachlorophenol-oil solution to penetrate the wood. Penetration takes place after the post has been set in the ground and is complete when the gel is no longer visible.

Initial test results are promising. Square Douglas fir post-stubs with ¼-inch and ½-inch coatings of penta-gel are all sound after 4½ years in the ground. Over the same period, 30 percent of the untreated control posts failed completely, 40 percent decayed, and only 30 percent remained sound. — *K. R. Peterson*



Penta-gel is being applied with a spatula on a 4 x 4 Douglas fir (*Pseudotsuga menziesii*) test stub. This material seems promising for treatment of fence posts.

Research Designed to Increase the Production of Lambs per Ewe

Current research at the University of Illinois and elsewhere is improving our understanding of reproduction in sheep. Natural production per ewe tends to be low because of relatively low lambing percentages and high death losses before lambs reach market age.

Death losses have been analyzed in an extensive study of lambing and lamb-performance data. The records studied are considered unique in that they were carefully kept for 37 years (1921 to 1957) by one man — W. J. Hampton, a shepherd in continuous service at the University.

The records involved 4,231 lambs. About 15 percent of the single lambs and 23 percent of the twin lambs were born dead or died before they were 150 days old. This means that for each 100 sets of twins born, 69 more lambs were marketed than when 100 single lambs were born.

Death losses, in percent, by breed were: Hampshires, 23; Rambouillets, 15; Shropshires, 17; Southdowns, 21. The breeds did not differ significantly in recognized cause of death; but Hampshires had the most deaths attributed to pneumonia; and Rambouillets, the most attributed to poor milking performance of the ewe.

Percentage of lambs alive at 150 days was 103 for Hampshires (that is, 103 lambs for every 100 ewes), 110 for Rambouillets, 106 for Shropshires, and 95 for Southdowns.

Research projects now in progress are further identifying and clarifying the genetic and physiological factors that influence reproduction in sheep. Eventually it should be possible for ewes to produce two or more high-quality lambs every 8 months. Quality lambs could then be available throughout the year and the reproductive rate per ewe would be increased by more than 100 percent. — *U. S. Garrigus, E. E. Hatfield, B. B. Doane, H. W. Norton*

Progress Toward Producing Corn Hybrids Resistant to Stalk Rot

Stalk rot is the most serious disease of dent corn in Illinois. The fungi causing this disease invade the roots and stalks after pollination. They spread rapidly, killing first the leaves and then the stalk. When stalks are killed early, ears stop developing and become chaffy. Diseased plants often lodge as rotting of the interior pith tissues seriously weakens the lower internodes and causes them to crush easily. By harvest time about half the corn plants in the state are infested, causing an average loss of about $500 to every farmer growing corn.

The use of disease-resistant hybrids, developed from resistant inbred lines, is one way to reduce losses. Evaluation of hundreds of inbred lines has revealed many that are resistant. Before resistant hybrids can be developed, however, the mode of inheriting resistance to stalk rot must be understood. To obtain this information, the Department of Plant Pathology has conducted tests in three years.

In 1954 results were obtained from three generations of a resistant and a susceptible parent. These generations were the F_1 (a first-generation hybrid between two inbred lines), F_2 (a segregating progeny from an F_1 hybrid), and backcross (F_1 crossed with one inbred parent). Two thousand plants were inoculated and examined.

The resistance of the F_1 was intermediate between that of the two parents. Most plants in the F_2 generation were also somewhere between the two parents, but some were like the resistant parent and some like the susceptible one. Average resistance of the F_2 was a little less than that of the F_1. The two backcrosses tended to approximate their respective inbred parents. On the basis of these tests, resistance to stalk rot appears to be inherited in a typically quantitative pattern.

In 1959 six segregating F_2 populations were evaluated. Results were similar to those in 1954. Distribution of F_2 plants for stalk rot reaction was in the main about normal, with average reaction close to the average of the two parents. Some F_2 plants, however, had less stalk rot than the resistant parent, and some were more resistant than either parent.

Twenty-two segregating populations and their parents were studied in 1960. Resistant $\times$ resistant and susceptible $\times$ susceptible crosses were studied as well as crosses between resistant and susceptible inbreds. Some inbred parents were intermediate in reaction to stalk rot.

Hybrids and F_2 populations tended to be more susceptible than the average of the two parents, with the difference in 1960 being greater than in previous years. Hybrid reaction, however, tended to follow that of the parents. The most resistant hybrids were obtained by combining resistant inbreds. Some inbred lines were more potent than others in transmitting resistance.

More data on the inheritance of resistance to stalk rot are needed. Available information indicates that resistant hybrids can be produced and that the disease reaction of the hybrid is generally proportional to the disease reaction of the inbreds in its pedigree. — *A. L. Hooker*

Effects of Molybdenum on Soybeans Studied

Because of the recent widespread sales of molybdenum (Moly-Grow or Moly) as a fertilizer seed treatment for soybeans, the Department of Agronomy has undertaken an extensive study of this practice.

Last year P. E. Johnson and L. Boone conducted trials on six experimental fields in central and southern Illinois. They treated soybean seed in such a way as to apply about ¼ ounce of sodium molybdate per acre. Treated seed was placed in one planter box of a two-row corn planter, and untreated seed in the other box. The beans were then planted in the normal way across all the fertility soybean plots on the

six fields. This gave replicated experiments on more than 200 plots.

Molybdenum treatment did not affect yields except on the Carlinville field. On all plots at Carlinville a slight, but consistent, increase was obtained. Chemical analyses of plants and soils are in progress.

In the fall, S. R. Aldrich asked 196 farmers about the results they had obtained by treating seed with molybdenum. These are the answers:

Effect of treatment	*Percent of farms*
Increased yield	24
Did not affect yield	32
Reduced yield	4
No fair comparison	40

Many of the reported increases were only ½ to 1 bushel per acre. These must certainly be discounted as questionable, leaving about 10 to 15 percent of the farms with increases of 2 to 4 bushels.

In summary, then, the available information at this time does not favor the possibility of any widespread response of soybeans to molybdenum in Illinois. Data are insufficient to permit positive recommendations either for or against the use of molybdenum in any specific area. Further studies are contemplated for 1961. — *A. L. Lang*

Is Present System of Sampling Fields for Soil Tests Still Adequate?

One of the most important factors in interpreting the results of a soil test is the quality of the soil sample itself. To be of value as a fertility indicator, any sample must be truly representative of the area from which it was obtained.

The present grid system of sampling fields, as suggested by the University of Illinois, was developed as a result of studies by Dr. F. C. Bauer and others. They studied the fertility patterns of fields which had received little or no fertility treatment. Since then, however, the use of limestone and fertilizer has become widespread and has affected the fertility patterns of the treated fields.

Studies are now underway in the Department of Agronomy to determine whether the grid system is the best method of sampling fields which have received fertility treatment. It is our desire either to confirm the effectiveness of the present system or to develop a more efficient and accurate method which may be used by farmers and professional personnel.

Preliminary studies indicate that the grid system is satisfactory in fields that are uniform in soil type, drainage, topography, and fertilizer treatment. One 40-acre field was sampled at 254 locations and the results of the soil tests were compared with those from 11 composite samples obtained under the grid system. No practical differences were observed in the average values for acidity, potassium, or acid-soluble phosphorus.

Proposed studies include tests for acidity, phosphorus, and potassium on fields which are not uniform in crop history, soil type, treatment, etc., as well as in large fields developed by combining several small fields into one. Future studies will also involve subsoil samples in addition to samples from the plow layer. — *J. C. Laverty*

COMING EVENTS

(A partial list of meetings scheduled at Urbana)

Apr. 12-13: Illinois Bankers' Agricultural Conference

May 13: FFA Awards Day Program

May 15-19: Leisurecraft and Counseling Camp (4-H Memorial Camp)

June 20: Illinois Crop Improvement Association Annual Meeting

June 21: Illinois Seed Dealers and Illinois Crop Improvement Association Tour, Agronomy South Farm

Different Methods of Laundering Elastic Fabrics Are Tested in Laboratory

Stores selling garments containing elastic fabrics often tell the purchaser to hand-wash them in a cold or lukewarm soap solution and then to dry them away from direct heat. Such directions are often impractical for boxer style underclothes or for children's slacks which use elastic braids or webbings for waistline fit. Consequently, a study of the effect of type of detergent, washing temperature, and type of drying (air versus tumbler) on the retention of elasticity was carried out by the Department of Home Economics. Elastic braids and power nets (knitted elastic fabrics for foundation garments) were included in the study.

Washing rubber-based elastic braids and power nets 40 times in a top-loading automatic washer at temperatures of 70°, 100°, or 135° F., using any of 24 soaps and synthetic detergents available in a supermarket, caused no damage when clean terry towels were used as load pieces. When soiled sheets and pillowcases were used as the washing load, however, many of the braids completely lost their elasticity. Nylon braids were damaged more than rayon braids, probably because nylon attracted more oil from the soiled load. Power nets had only slight losses of elasticity.

Less elasticity was lost when the soiled loads were washed with soaps rather than with general-purpose synthetic detergents or with one of the specialty detergents sold for elastic fiber care. This is because soap has better oil-suspending power.

When clothes were tumble-dried at the medium heat or "wash and wear" setting, they didn't lose as much elasticity as when air-dried. Elastic fabrics containing rubber should not be dried in sunlight.

Power nets containing a spandex (synthetic) elastic fiber were undamaged by any washing condition tested. — *Ruth Galbraith, Janice Maclin, and Joan Freitag*

FARM BUSINESS TRENDS

Most of the surplus stocks of farm products consist of three crops — wheat from the Great Plains, cotton from the South, and corn from the Midwest. Together these three crops account for 47 percent of all crop acreage and 48 percent of the total value of all crops produced in the United States. (See pie chart, Figure 1.)

Wheat. This is our most overpriced and overproduced crop. Our annual food requirements are around 490 million bushels, while our five-year average annual production is 1,180 million bushels. We manage to export (give away or sell at cut-rate prices) about as much as we use for food. Around 63 million bushels are used for seed and 50 million fed to livestock.

By next July 1 the carryover of old wheat will be near 1.5 billion bushels. Practically all of this surplus consists of hard wheats that are produced on the Great Plains from Texas to the Canadian border. Most of these stocks were built up from just three crops — those of 1952, 1953, and 1958. (See the bar chart, Figure 2.)

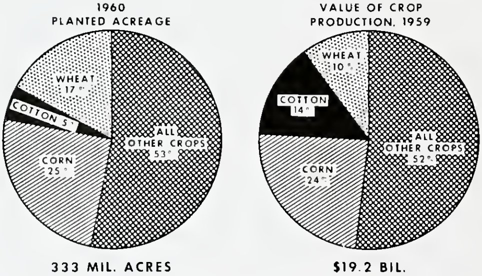
Cotton. Carryover stocks of cotton reached their peak in 1956, and have been cut nearly in half since that time (Figure 2). The surplus was built up from 1952 to 1956 when our cotton was largely priced out of world markets. It has been worked off in part by selling at cut-rate prices to foreign buyers.

Cotton production has not increased materially for over half a century. The average annual production of the past five years, 13.0 million bales, was equaled in 1908-1912. At that time 67 percent of the crop was exported, but in the last five years exports took only 45 percent of our production.

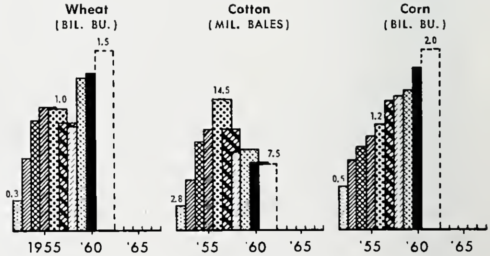
Corn. The carryover of corn has increased each year for nine consecutive years. The carryover next October 1 will be near 2.0 billion bushels (Figure 2).

The expected carryover of corn is equal to about one-half of the average annual production for grain in either of the past two years. The nine-year accumulation represents 7 percent of all the corn that was produced, but it is equal to only 2 percent of all of the feed that was used during these years.

In recent years about 82 percent of our corn has been fed to livestock, 7 percent has been processed for food, starch, and alcohol, and 4 percent has been exported. Sales for export have been at prices that are only a few cents lower than our market prices. — *L. H. Simerl*



The circle on the left shows the relative acreages of cropland planted to wheat, cotton, and corn, and the one at the right shows relative values. (Fig. 1)



The three groups of bars show the carryovers of wheat, cotton, and corn from 1952 through 1960. Dotted outlines show estimated carryovers for 1961. (Fig. 2)

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Summer, 1961

ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

IN THIS ISSUE

Gleaning lambs can add $10 an acre to the value of your corn crop (page 8).

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ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

CONTENTS

Summer, 1961 Volume 3, Number 3

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RESEARCH IN THE DEPARTMENT OF FORESTRY

deals with various aspects of forest management and with the technical properties and uses of wood. There is no overproduction of forest products. Illinois and the nation will need all the wood that can be produced now and in the foreseeable future.

Much of the research in the department is biological, in that it is concerned with the life history of trees, woodlands, and forest plantations — their requirements, growth rates, responses to management practices, and susceptibility to diseases and insect attack. Other biological studies include tree breeding and selection to improve tree form; the technical quality of the wood or the rate of growth; nursery investigations to improve the quality of forest planting stock; and the response of various species to shearing practices designed to improve the quality of Christmas trees.

Economic studies include the costs and returns in the management, harvesting, and marketing of products from Illinois woodlands, forest plantations, and Christmas tree farms. Additional studies seek other incentives and deterrents to better woodland management and marketing.

The Department of Forestry is studying the hydrology of a forested watershed in southern Illinois. Surface water resources are important in the economic life of that area.

Research in the technical properties and uses of wood includes the harvesting and processing of native timber and products from forest plantations, the adaptability of native timber to farm construction, and the preservative treatment of species grown in Illinois. — *J. N. Spaeth, Head of the Department*

Dr. Spaeth has been Head of the Department of Forestry since 1938. At the same time he has conducted research in silviculture, seed physiology, and forest management, and has published many articles on these subjects.

How Does 2,4-D Kill a Plant?

J. B. HANSON and F. W. SLIFE

EVEN WITH ALL the new weed control chemicals on the market, 2,4-D is still the most valuable one we have. Since 1945, when it first became available, it has annually saved farmers millions of dollars. It is now produced at the rate of 30 million pounds a year.

How does 2,4-D kill a plant? The answer to this question has not been found, although many theories have been proposed. Current work at the Illinois station is aimed at learning more about the action of this compound.

What happens in the plant?

Radioactive 2,4-D is being used to study the penetration, translocation, and rate of breakdown of 2,4-D in plants. We have found that resistance to 2,4-D cannot be explained by lack of penetration or translocation of the compound. Although wild cucumber is resistant, 2,4-D could penetrate and be translocated through the plant (Fig. 1).

After these results, we made further studies on wild cucumber to learn what happens to 2,4-D once it has entered the plant. After 24 hours only 18 percent of the 2,4-D in the plant was still 2,4-D. The rest had been converted to other compounds. Some of the applied 2,4-D had been given off as $C^{14}O_2$, indicating that the 2,4-D molecule was broken down.

The action of 2,4-D was then compared with that of 2,4,5-T, a compound to which wild cucumber is sensitive. Like the 2,4-D, the 2,4,5-T was applied in radioactive form. Less of the 2,4,5-T than of the 2,4-D penetrated the plant. What did penetrate, however, was readily translocated (Fig. 2). After 24 hours, 78 percent of the 2,4,5-T in the plant was still pure 2,4,5-T, indicating that it was much more resistant to breakdown than 2,4-D in this particular species.

These studies indicate that resistance to 2,4-D may be closely correlated with the rate at which the plant can break down the 2,4-D molecule.

2,4-D affects growth

2,4-D is a synthetic growth hormone, or auxin. In plants that do not readily break down 2,4-D, the compound produces growth aberrations which lead ultimately to death. The clue to its action must therefore lie in the abnormal growth produced. Indeed, the common witticism, "2,4-D makes plants grow themselves to death," is basically sound. But what is growth, and how does 2,4-D modify it?

Growth in plants is a two-phase process. At the tip of roots and shoots are meristematic regions — that is, the cells can divide to produce new cells. Some unknown stimulus, probably hormonal, keeps these cells ever young, ever dividing. After a cell divides, the more basal of the two daughter cells escapes the "ever young" influence and embarks on the second phase of growth.

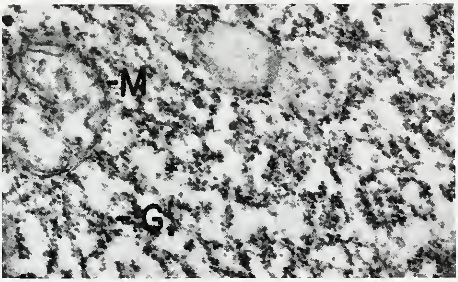
During this phase a cell grows in length. A low concentration of indolacetic acid, a growth hormone found in the plant, influences this elongation. As the cell elongates and matures, it synthesizes considerable protein and lipid, and becomes more efficient in such physiological processes as salt uptake, translocation, and respiration.

When 2,4-D is sprayed on a susceptible seedling or young plant, the normal growth pattern changes markedly. Meristematic cells quit dividing — as if the cell-division

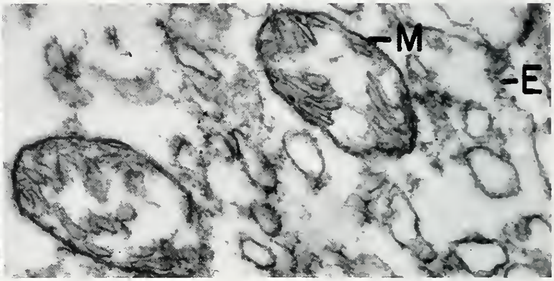
Radioactive 2,4-D was applied to the plant at near right in top pair of pictures. Movement of the 2,4-D is indicated by dark areas in the radioautograph at far right. The very dark leaf is the one to which 2,4-D was applied. (Fig. 1)

Plant to which radioactive 2,4,5-T was applied is shown in photograph and radioautograph at bottom right. (Fig. 2)

F. W. Slife, Associate Professor of Crop Production, and J. B. Hanson, Professor of Plant Physiology, compare a photograph and a radioautograph of a plant in their laboratory.



Electronmicrograph of part of the cytoplasm of a meristematic or dividing cell. The small granules (G) are ribosomes, centers of protein synthesis. Immature mitochondria are seen at M. (Fig. 3)



Electronmicrograph of part of the cytoplasm of a mature cell. By now the ribosomes have disappeared. The membranous material has become quite prominent, and the mitochondria have developed internal membranes, or cristae. (Fig. 4)

mechanism were suddenly fixed in place. Elongating cells no longer grow longer, but do grow wider.

The mature, functional parts of the root and shoot are also affected. First the cells swell and then they begin to divide, producing callus growth (a mass of undifferentiated dividing cells) and root primordia (rudimentary root meristem).

All these changes produce a plant with little or no root elongation, and with abnormal growth in the basal stem. Young leaves will not expand properly, but develop an abnormal, compact mesophyll (green tissue between the epidermal layers of a foliage leaf) that is low in chlorophyll.

A number of the plant's functions thus become impaired. Roots lose some of their ability to take up salt and water, photosynthesis is reduced, and the phloem tissue can no longer transport much food material through the plant. All these disruptions probably contribute to the plant's death.

If the plant can slowly degrade the 2,4-D it will survive and eventually resume growth, but it will be weak and unable to compete with plants that were not susceptible.

What causes the growth changes?

Even though we can observe the changes in growth that occur after 2,4-D is applied, we still don't know what 2,4-D is doing in the cell to cause these aberrations. For this reason we have examined the changes occurring in the cytoplasm, or living substance of the cell as it grows.

Figures 3 and 4 are electronmicrographs of the cytoplasm of meristematic (ever-young, immature) cells and elongating cells, respectively. The cytoplasm of the ever-young, dividing cell (Fig. 3) is characterized by a dense population of small granules, some very thin membranes, and by immature mitochondria with poorly defined internal structure.

The granules (ribosomes) are composed of ribonucleic acid and protein, and are intimately concerned with protein synthesis. The ribonucleic acid seems to provide a template, or organizing surface, where protein is formed.

From the distribution of the granules in Figure 3, we can detect the presence of the membranes (endoplasmic reticulum). The membranes connect various portions of the cell and also bound it. They contain the enzymatic system for salt accumulation and may be the centers for other enzymatic reactions.

The mitochondria are the power plants of the cell, producing usable energy from the oxidation of substrate sugars and acids.

As cells elongate, the cytoplasm changes markedly (Fig. 4). The granules disappear, apparently metabolized in the process of protein and lipid synthesis. Membranes thicken and become much more prominent. Mitochondria develop internal membranes and reach peak efficiency. Cytoplasm of this type is mature and fully functional.

Now what does a herbicidal concentration of 2,4-D do to cell growth? Although our experiments are not complete, the results thus far strongly suggest that 2,4-D prevents the immature cytoplasm from changing into mature, functional cytoplasm. In addition, the mature cytoplasm seems to revert, at least in part, to the immature stage. As the cytoplasm reverts, the number of granules, or ribosomes, increases greatly. This is evidenced by an increase in ribonucleic acid. Shortly afterwards, the cells start to divide.

Since so much ribonucleic acid is produced, 2,4-D must evidently work through some phase of nucleic acid metabolism. It may be that 2,4-D has two effects: It induces the nucleus to form more ribosomes and it also blocks the normal expansive-growth metabolism of the ribosomes.

Oddly enough, very low concentrations of 2,4-D promote growth and make the ribosomes disappear faster.

Ultimate benefits

The experiments with 2,4-D at this and other universities will eventually lead to better weed control with herbicides. Furthermore, it is likely that as a byproduct of the research we will gain knowledge about the fundamentals of growth that can be applied to a more abundant crop production.

Factors influencing the WORLD MARKET for U. S. SOYBEANS

S. C. SCHMIDT, author of this report, came to Illinois in 1959 as Assistant Professor of Agricultural Economics. He received his early education at the University of Budapest, Hungary, and his Ph.D. degree from McGill University, Canada.

During the past decade, U. S. exports of soybeans and soybean oil have increased spectacularly. Exports of beans rose from a low of 27 million bushels in 1950 to 132 million bushels in 1959-60. Between 1952 and 1959 exports of crude oil increased from 102 million pounds to 340 million.

Western Europe provided the largest market for U. S. fats, oils, oilseeds, and oilseed products. European countries also took a large share of our soybeans. Between 1950 and 1959 this share has varied from one-fourth to a little over one-half of our exports.

Of the 12 European countries buying significant quantities of U. S. soybeans, the Netherlands, Belgium, and West Germany are the principal ones. Japan, however, buys more beans than any other single country. Next in importance are the Netherlands and Canada.

Twelve factors analyzed

The market for soybeans is complex and is affected by a great many interrelated factors. Some simplification was therefore necessary before any attempt could be made to analyze the most significant relationships influencing the world market for U. S. soybeans.

Six major markets were selected for study: Western Europe as a whole, Belgium, West Germany, the Netherlands, Canada, and Japan. Exports to these markets were expressed in thousands of bushels.

On the basis of available evidence, 12 economic factors appeared to be the main forces accounting for changes in soybean exports. The analysis was therefore limited to these 12, which are as follows:

1. Level of world supply of soybeans, including that of the importing countries (in thousands of bushels).
2. Production of oilseeds in the importing countries (in thousands of metric tons).
3. World production of fats, oils, and oilseeds, excluding soybeans, expressed as edible vegetable oils (in thousands of short tons).
4. World exports of fats, oils, and oilseeds excluding soybeans, expressed as edible vegetable oils (in thousands of short tons).
5. World exports of copra and coconut oil in terms of oil (in thousands of metric tons).
6. International market prices of oilseeds (1952-1954 = 100).
7. International market prices of 10 fats and oils (1952-1954 = 100).
8. U. S. wholesale prices of high-protein feeds (1947-1949 = 100).
9. Per capita gross national product of importing country (1953 = 100).
10. Terms of trade of importing country (1953 = 100).
11. Level of gold and dollar reserves of importing country (in millions of dollars).
12. Number of grain-consuming animals in importing country (in thousands of animal units).

To determine the effects of the 12 trade-affecting factors, or "independent variables," we first used a technique known as regression analysis. From the results of this analysis we derived elasticity coefficients. These coefficients indicate the percentage change in exports that can be expected for every 1-percent change in the variable.

The five factors that were found to be most important are shown in Table 2, and are discussed briefly in the following paragraphs.

Response to price

During the 1950's a 1-percent increase in international price of oilseeds was associated with a 0.23-percent decrease in U. S. soybean exports to Europe. Conversely, a 1-percent decline in this price was accompanied by a 0.23-percent increase in soybean exports. Except for Belgium, other markets followed a similar pattern of response.

Table 1. — United States Soybean Exports to Six Major Markets, 1950-1959[a]

Year beginning July 1	Total	Europe	Japan	Netherlands	Canada	West Germany	Belgium Luxembourg
			(thousand bushels)				
1950	26,904	8,771	11,170	964	5,164	0[b]	511
1951	16,009	5,413	3,992	1,476	3,921	2	1,570
1952	30,392	7,380	14,408	2,678	3,963	1,557	732
1953	41,498	15,552	17,357	5,929	4,794	4,674	999
1954	51,087	19,140	16,750	5,550	7,870	5,461	585
1955	71,097	35,382	21,632	9,764	8,474	14,122	1,950
1956	76,686	39,015	20,181	12,598	10,412	13,858	2,626
1957	87,936	42,937	24,413	12,441	9,795	12,366	2,639
1958	102,829	41,390	36,071	13,432	13,653	12,635	3,853
1959	132,981	60,728	41,093	22,901	16,760	14,443	3,928

[a] U. S. Dept. Agr., For. Agr. Serv., Foreign agricultural trade of the United States, by countries.
[b] Less than 1,000 bushels.

Table 2. — Percentage Effects of a 1-Percent Change in Five Selected Factors, on U. S. Soybean Exports to Six Markets[a]

Factor	Europe	Belgium	West Germany	Netherlands	Canada	Japan
International market prices of oilseeds, 1952-54 = 100	−0.23	0.35	−0.25	(b)	−0.45	−0.30
Gold and dollar reserves	0.22	0.66	0.84	(b)	1.48	(c)
Per capita gross national product, 1953 = 100	0.64	(b)	(b)	0.25	(b)	(c)
World output of fats, oils, and oilseeds, excluding soybeans	−0.57	(b)	0.47	(b)	1.65	−0.60
Production of oilseeds in importing countries	−0.13	(b)	(b)	−1.15	0.56	(c)

[a] Regression coefficients expressed as first differences of logarithms.
[b] Elasticity not significantly different from zero.
[c] No estimate made.

Gold and dollar reserves

For most Western European countries and Canada, gold and dollar reserves constitute the most important single force stimulating imports. The emergence of large gold and foreign exchange balances is but one sign of the extent of Europe's recovery and advance toward a freer trade system. Most Western European countries have now lifted the restrictions on taking currencies out of the country. These developments indicate that financial reasons for discriminatory import regulations no longer exist.

Per capita gross national product

Only the European market as a whole was significantly influenced by the level of per capita gross national product. This does not mean, however, that the effect of this variable was inconsiderable. Per capita gross national products were on the rise in the 1950's, and together with an increase in population and improvements in diets, greatly expanded the food and feed use of soybeans and soybean products.

World supply of fats, oils, and oilseeds excluding soybeans

An increase in supply of substitute products affected American exports to Europe and Japan. A 1-percent increase in world output of fats, oils, and oilseeds decreased sales to these two markets by about 0.6 percent. It is of interest that neither West Germany nor Canada reduced their purchases as substitute products increased.

Higher output of oilseeds in importing countries

This factor was less important than world supply of substitute products in shaping the directional pattern of U. S. soybean exports. Evidently European endeavors toward self-sufficiency in these products thus far have not materially interfered with American exports.

Other factors

Of the 12 trade-affecting factors analyzed, three others deserve special mention — world supply of soybeans, trade in copra and coconut oil, and number of grain-consuming animals. Although not included in the analysis, U. S. production of soybeans is, of course, very important in determining the amount of beans available for export.

World supply of soybeans, expressed either as trends in production or as exports by China and other countries, was not closely correlated with American exports. This may seem paradoxical, but is explicable by the unique nature of the soybean economy. The U. S. and China are the major exporters. Supplies from other countries are relatively small and are largely absorbed within domestic markets. China's exports, however, are usually unrelated to domestic demand and supply, except in extraordinary circumstances like those prevailing in the current marketing season. Internal needs are subordinate to the achievement of international aims. China might therefore export more beans in a poor crop year than in a good one, thus upsetting the predicted effects of total world supply.

It is worth mentioning that changes in world trade in copra and coconut oil did not affect U. S. soybean exports. One might be tempted from this scanty information to conclude that copra is regarded as an inferior substitute for soybeans, or that, coming from so-called "soft currency" countries, it may not be subject to import restrictions.

Because of the close interdependence between changes in per capita gross national product and the number of grain-consuming animals, the effects of the latter variable are not given. Foreign demand for soybeans and products is partly a derived demand interrelated with the consumption of meat and other livestock products, which in turn is affected by changes in income and relative prices.

Future prospects

A continued rise in per capita gross national product, population, and meat consumption should expand our soybean market. The market should receive additional support if the importing countries maintain a strong foreign exchange position.

On the other hand, American export prospects could be adversely affected if countries belonging to a major regional economic group (like the European Common Market or the European Free Trade Association) adopt protectionist trade policies. If they try at the same time to achieve self-sufficiency, by price supports for instance, the consequences would be more severe. Then, too, should inefficiencies in techniques and land tenure systems be overcome in countries heretofore considered marginal exporters, an increase in world supplies must be expected.

All things considered, concrete proved the best material for slatted floors.

Animals seemed as contented on wood-slatted floors as on the concrete slats.

Animals on quarry screen were reluctant to move, and their hooves showed wear.

SLATTED FLOORS for raising SWINE

C. K. SPILLMAN and E. L. HANSEN

INTEREST is growing in slatted floors for hogs, mainly because they reduce the labor needed for cleaning. The animals work the droppings through the slots in the floor and keep themselves clean. Manure can then be removed from under the slats without interference from animals and equipment.

Slatted floors are not new. They originated in Iceland some 200 years ago. Gradually the idea spread to Europe. Some work has been done there in designing and testing floors for farm animals, but it is still in the development stage.

In this country, the poultry industry has been using raised floors for many years. Some farmers are using them for swine, but little is known about the requirements for an overall system or the benefits and limitations of such a system.

Three materials tested

On January 18 of this year, pigs were put on three test floors which had been installed above the existing floor in the Hog-O-Matic facility at the swine farm. Three different materials were used for the test floors — concrete slats, wood slats, and quarry screen. The primary purpose of this test was to observe the pigs during the finishing period and determine which of the flooring materials appeared best.

The flooring materials covered the full area of the pens. Concrete slats had a top width of 5 inches and tapered to a 3-inch width at the bottom. Wood slats were made by cutting 4 x 8 Douglas fir timber into two equal parts. The cutting was done at a 15-degree angle, so that each slat had one tapered side, and a top width of slightly over 4¼ inches. Both concrete and wood slats were spaced 1 inch apart. Openings in the quarry screen were about 1 inch square.

Pens were about 6 by 12 feet, with 10 pigs in a pen. This gave approximately 7 square feet per animal. The area of the pen was not changed during the growing cycle, which started when the pigs weighed about 50 pounds.

How materials compared

Pigs raised on the concrete and wood slats have shown no visible ill effects. Animals on the quarry screen have been rather reluctant to move around and their hoofs show some wear.

For obvious reasons, the quarry screen was superior in self-cleaning action. There was not much difference between the concrete and wood slats in this respect.

Other factors that need to be considered when choosing a flooring material include durability, anchorage, dimensional stability with changes in conditions, and cost. On the basis of all factors involved, concrete would appear to be the best choice.

New finishing house

The results of this test have been used to design a finishing house for 15 litters, which will be installed on the Moorman Breeding Research Farm. There it will be possible to compare this system with other systems of raising hogs. Other problems connected with cleaning and ventilation will also be studied.

C. K. Spillman is Assistant in Agricultural Engineering, and E. L. Hansen is Professor of Agricultural Engineering.

Gleaning Lambs Find HIDDEN GOLD in ILLINOIS CORNFIELDS

E. E. HATFIELD, B. B. DOANE, and U. S. GARRIGUS

Any program that can increase returns by $10 or more an acre deserves a second look. Such a program is possible on Illinois' 10 million acres of cornland through the better use of corn forage or stover.

Many farmers consider that stover is a necessary by-product of grain production and is not economically salvageable. Yet cattle and sheep can convert this roughage into quality fiber and nutritious foods.

Feeder lambs are somewhat better for gleaning than other livestock, because they can be turned into standing corn of the commonly used hybrids without severely damaging the grain yields. They can also pick up the grain shattered and dropped by a picker-sheller during harvest, while cattle would have to pass it up.

By letting lambs glean small grain stubble and cornfields, some producers have overcome the weak price spread between feeder lambs and slaughter lambs. Occasionally lambs have reached market weights and finish without requiring additional harvested feeds.

Feeder lambs have been used experimentally to glean cornfields on the Animal Science farm at Urbana for 6 years. The following recommendations are based on the results.

Processing the lambs

If feeder lambs are not adequately processed before being turned into the cornfield, their performance may be poor. The lambs should have a few days in drylot to recover from shipping fatigue. During this time they should have access to good-quality hay (preferably not more than 50 percent legume), water, and minerals. They should be crotched or shorn, vaccinated against enterotoxemia, implanted with 3 milligrams of stilbestrol, drenched for internal parasites, and dipped for external parasites.

The lambs may be turned directly into standing corn after they have been processed and have recovered from shipping fatigue. For post-harvest gleaning, however, they should not be turned into the cornfield until at least 2 weeks after they have been vaccinated for enterotoxemia. Some producers use this 2-week period to get the lambs on a full feed of grain. If this has not been done, the lambs should be filled with some dry feed just before they are turned into the cornfield.

Stocking rate per acre

Several factors determine the number of lambs that will give maximum utilization without overstocking. These include the amount of forage in the lower corn leaves and the interrow growth (grass, weeds, or crops), which in turn are affected by soil fertility, climatic conditions, and plant populations. The predicted date of harvest should also be considered. Stocking rate after harvest will depend on the amount of grain dropped because of insect damage and inefficient picking.

In the experiments on the Animal Science farm, the number of lambs varied from 2 to 14. It appeared that 2 to 4 lambs was a reasonable stocking rate for a good corn growing season. Within limits, fewer lambs per acre will result in more gain per lamb but less gain per acre.

After 2 weeks in this cornfield, lambs have gleaned many of the lower leaves. Cover shows the same field on the day that the lambs were turned in.

When to stock

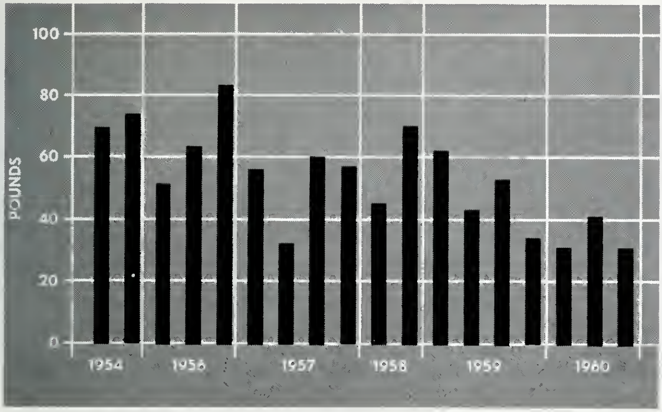
As the preharvest gains will be from forage (lower corn leaves and interrow growth), it is desirable to put lambs in the cornfields before the corn becomes too mature and loses much of its nutritive value. Dry mature corn leaves are not too acceptable as a livestock feed.

"When the cornsilks are dry and the corn is in the dough stage" is a commonly accepted rule of thumb for turning lambs into cornfields for preharvest gleaning. The experimental lambs were turned into the fields on various dates between August 10 and August 23, and remained until they had gleaned the grain dropped during harvest or until they had reached market weight.

Livestock gains per acre

During the 6 years, lambs were turned into a total of 18 cornfields for preharvest gleaning. Lamb gains per acre varied from 32 to 84 pounds (see graph) with an average of 54 pounds. Valued at 20 cents a pound, the average preharvest gain was worth more than $10.

Postharvest gains averaged slightly more than 70 pounds, or about $14 an acre. These postharvest gains were probably higher than could normally be expected, because they



Lamb gains per acre from preharvest gleaning.

included two seasons when corn borers caused a high corn drop.

An epidemic of coccidiosis in 1960 markedly reduced the performance of the feeder lambs used.

Effect on grain yield

In 1958, the gleaned half of a cornfield yielded slightly more grain than the ungleaned half. The difference could be due to factors other than gleaning. It has been suggested, however, that during a dry season, like that of 1958, proper gleaning might increase grain yields because the lambs would glean grass and weeds that compete with corn for moisture and plant nutrients.

During normal seasons preharvest gleaning will usually reduce grain yields, especially in cornfields that are overstocked. In 1960, ungleaned outside check rows yielded 5 to 8 percent more than gleaned outside rows. A comparison of the middle rows would probably have shown less difference. Outside rows were normally gleaned more closely than middle rows — particularly in the early part of the period.

In general, gleaning did not cause great reductions in yield. Several preharvest-gleaned cornfields yielded more than 100 bushels of 15-percent moisture corn per acre.

Interplanting the corn with either rye or alfalfa reduced grain yield.

Effect of Shearing and Stilbestrol Implants on Average Gain per Head[a]

Treatment	1958	1959	1960[b]
	pounds of gain		
Wooled (implanted and nonimplanted)....	23.1	19.7	14.2
Shorn (implanted and nonimplanted)........	28.0*	23.0	17.3*
Nonimplanted (wooled and shorn)	23.0	19.2	....
Implanted (wooled and shorn)	28.1*	22.7**	....
Wooled and nonimplanted...........	21.3	18.6	....
Shorn and implanted...	29.3	24.6**	....

[a] Three milligrams of diethylstilbestrol per head.
[b] All lambs were implanted.
* Probability that difference was due to chance is less than 5 in 100.
** Probability that difference was due to chance is less than 1 in 100.

Shearing and stilbestrol implants

Shearing and implanting with 3 milligrams of stilbestrol increased average gains (see table). These results are in agreement with other trials conducted at this station. Because the program starts in hot weather, shearing or crotching reduces fly strikes.

Supplemental feeding

Lambs must have access to minerals while gleaning. Equal parts of salt, limestone, and bonemeal make a good, economical mixture.

Judging from the chemical composition of corn forage, one would expect protein supplements or grain, or both, to be beneficial during the preharvest and postharvest periods. In trials at Urbana, however, neither linseed meal nor alfalfa meal pellets increased gains. These results are not based upon enough data to rule out supplements under all conditions. Some lamb feeders have reported good results from permitting lambs to pass freely back and forth between the cornfield and a nearby meadow, stubble field, or pasture. It is frequently advisable to provide some good-quality hay during the postharvest gleaning period — especially if the fields were gleaned closely before harvest.

A convenient water supply is essential for good results, although it is sometimes hard to provide.

Finishing lambs in drylot

The transition from the postharvest cornfield to drylot for finishing should be made with extreme care. If lambs remain in the cornfield for a few days after the grain has been fully gleaned, they will probably overeat when given free access to corn in drylot.

Removing the lambs from the field before they have gleaned all the corn will greatly reduce the risk of overeating. Another method of reducing the risk is to put a grain-filled self-feeder in the field a few days before all the grain is gone.

The ideal situation on many farms would be to eliminate the need for finishing in drylot. This might be done by stocking the fields at a rate that would enable the lambs to reach market weight when most of the grain is gone. Remaining feed might then be gleaned by breeding animals.

A satisfactory method of finishing in drylot is to feed shelled corn in a self-feeder, and roughage (silage or hay) in silage bunks or hay racks. If the roughage is nonlegume, protein supplement, fed at a 10- to 15-percent level in the corn, is recommended. Minerals should be continued during the finishing period.

E. E. Hatfield is Assistant Professor; B. B. Doane, Assistant; and U. S. Garrigus, Professor of Animal Science.

RIGID FRAMES of REINFORCED CONCRETE For Farm Buildings

MAURICE L. PAUL and E. L. HANSEN

Buildings free of any interior supports, trusses, or braces have become possible through recent research in the Department of Agricultural Engineering.

First, rigid frames of lumber were developed to provide the structural framework for clear-span buildings (Illinois Research, Winter, 1960). More recently, we have investigated the possibilities of reinforced concrete rigid frames. With such frames, buildings can be constructed up to 40 feet wide and of any desired length in multiples of the frame spacing.

Fabricated by precasting plants

The objective of the study on concrete rigid frames is to develop a series of designs for use by concrete precasting plants. Because of the fabrication problems, the need for concrete quality control, and the weight of the frames, it is essential that they be precast, transported, and erected by a firm capable of handling such operations.

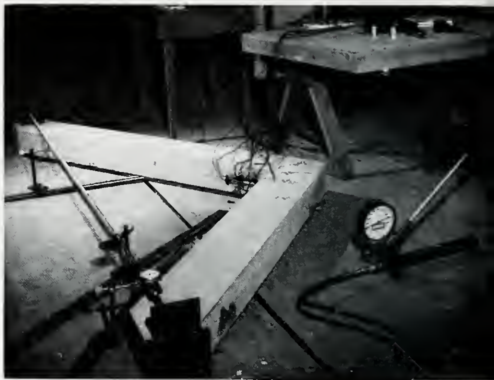
It is expected that the customer might be provided with the erected frames only, the rest of the construction materials and labor being selected and supplied according to individual circumstances. Or the customer might purchase a complete reinforced concrete building, delivered and erected as a packaged unit. This might include precast footings, frames, sidewall panels, and even precast concrete roof panels. Door and window hardware could be provided to complete the building, and precast concrete floor sections could be obtained if desired. A packaged building of this type has definite advantages when a completed structure is wanted or when skilled labor is unavailable.

Preliminary tests

To design test specimens for research purposes, a 36-foot span gable frame for 12-foot frame spacing was selected. Sidewalls were assumed to be 12 feet high and the roof slope, 4:12. This frame was theoretically analyzed for various loading combinations and designed accordingly.

Preliminary load tests were made to observe the behavior of the reinforced concrete rigid frame at the most highly stressed sections. Partial frames were made to represent the portion from a point in the sidewall leg to a point in the roof member, including the critical eaves section or knee of the gable shape (Fig. 1).

Two of the knee frames were tested in compression to duplicate conditions at the knee caused by dead and snow load on the roof. Two more of the frames were subjected to tension tests simulating conditions that would result from wind pressures on the inside of an open front shed. By means of electric strain gage measurements, load measurements, and visual observation, the



Preliminary tests were made on knee frames r resenting a portion of the complete rigid fra Results were used in designing a complete, f sized frame for further testing. (Fig.

behavior of the frames could be studied and information gained for the design of the full-sized frame.

Full-sized frame tested

On the basis of the preliminary knee frame tests and of further design calculations, a full-sized gable-shaped rigid frame with a 36-foot span was fabricated and tested to failure (Fig. 2). The frame was of 6-by-10 cross section from bottom to top, and was heavily reinforced with ⅞-inch round bars.

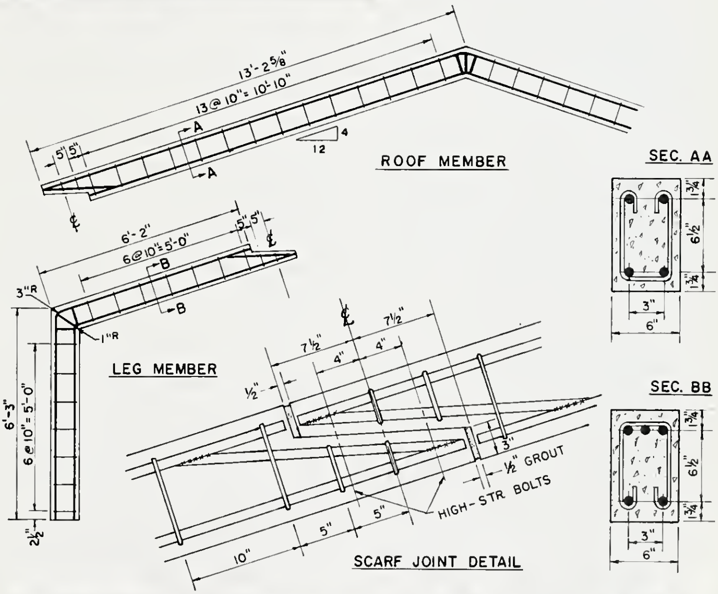
The frame was cast in three parts, including two leg sections similar to the knee frames in the preliminary tests and a center section to complete the gable arch (Fig. 3). After curing, the three component parts were bolted together with high-strength bolts, two on each side of the frame.

The test frame was thoroughly instrumented so that load and strain measurements could be taken and the behavior thoroughly studied. An approximately uniform roof load was provided by 18 hydraulic jacks connected in parallel with a master pump (Figs. 2 and 4).

Maurice L. Paul was formerly an Assistant, and E. L. Hansen is Professor, both in the Department of Agricultural Engineering.

Eighteen hydraulic jacks gave the effect of a uniform roof load on the full-sized, 36-foot-span frame (shown at left). It did not collapse even when subjected to pressure much greater than what it would receive during use. (Fig. 2)

As shown below, the concrete frame is heavily reinforced. Reinforcement varies with the span of the building, but the size of the concrete member remains the same. (Fig. 3)



Measured quantities compared very well with theoretical values of load capacity and deflection at the peak. The rigid frame was subjected to a maximum roof load nearly 2.5 times the design value. Even under this great load the frame did not collapse.

Buildings planned

On the basis of research results, plans are being made for two buildings. At least one is expected to be constructed this year.

A continuous foundation will not be required. The footings for the frames will be precast and set in a hole in the ground, which eliminates forming on the job. Sidewalls will be tiltup concrete panels. On one building, the panels will be insulated with a 1½-inch core of expanded polystyrene in the center of the concrete slab. A conventional roof system is planned.

This construction is very suitable for local manufacturing and construction services. It should be made available in many areas to serve both farm and industry.

oint of no moment was selected at which to bolt sections together. At a load of about twice the gn load, hairline cracks appeared in the concrete, hown by the ink marks. Note that, to the left he joint, the top of the concrete beam was in ion and that, to the right, tension was on the om. (Fig. 4)

Advances in Ice Cream Manufacture

JOSEPH TOBIAS

An average American family of five will probably eat more than 25 gallons of ice cream this year. Altogether almost a billion gallons of ice cream and similar frozen products are produced annually in this country. Illinois is one of the leading producers of ice cream, ranking fifth among the states.

Without a doubt, ice cream provides a substantial outlet for our agricultural products. Research both here and elsewhere is aimed at improving the efficiency of production methods and maintaining the quality and economy of this popular and healthful food.

Problems of modern production

At first glance it may seem difficult to realize that many technical problems are encountered in ice cream production. If grandmother had no difficulty making superb ice cream in her kitchen, why should there be problems in an industry that has the benefits of the latest engineering skills?

The answer is simply that grandmother's ice cream didn't undergo temperature changes and it was eaten within a day after it was made. Commercial ice cream, however, gets quite a bit of abuse after it leaves the plant and it must be made in such a way that its quality will not deteriorate under extreme conditions.

The manufacture of ice cream involves a number of processes, including standardization and blending of ingredients, pasteurization, homogenization, cooling, flavoring, freezing, packaging, and hardening. State and federal agencies have set minimum requirements for fat and milk solids content. In Illinois, for example, plain ice cream must contain 12 percent milk fat; chocolate, fruit, and nut ice cream, 10 percent. Public health agencies also enforce standards for pasteurization, sanitation, and bacterial count. The pasteurization requirement is especially valuable, for a number of food poisoning outbreaks have been traced to homemade, unpasteurized ice cream.

The ice cream manufacturer is concerned with quality criteria beyond those required by law. He tries to formulate a product with a highly acceptable flavor, a smooth, creamy consistency, and a built-in resistance to damage caused by partial thawing and refreezing.

For the best flavor, he must start with dairy ingredients of the highest quality. They must be processed in such a way that they are not susceptible to the chemical action of oxygen, which causes a "cardboardy" taste. He must also select highly desirable flavoring materials. Not only should the flavor be pleasing, but it should retain its characteristic aroma at low temperatures. Flavor manufacturers have made hundreds of materials available to the ice cream industry.

Consistency, or the body and texture of ice cream, is influenced by a number of factors, such as composition of the mix, homogenization pressure, heat treatment, and the rate of freezing and hardening. A "smooth" or "creamy" ice cream is one that contains extremely small and uniformly sized ice crystals. These can be achieved by very rapid freezing under vigorous agitation. Whenever the storage temperature is allowed to fluctuate, however, the crystals tend to grow and the product becomes grainier. The real problem, therefore, is to keep the crystals small until the ice cream is eaten.

One possible solution of the problem is to reduce the water content, which is normally about 60 percent. Although lowering the water content would result in a smoother ice cream with better keeping quality, this is feasible only to a certain point. Beyond this point technical difficulties are encountered and the product loses some of its refreshing quality. The cost of the ice cream is also increased.

Homogenization is an invaluable aid in producing a smooth-textured ice cream. It also prevents churning of the butterfat and aids in the incorporation of air. In ice cream as in whipped cream, air is necessary to give consistency. Too much, however, is detrimental. The law requires that no more than half the volume of ice cream be air.

Adding gelatin or vegetable gums, called "stabilizers," will reduce "free water" and increase smoothness. The function of these materials is sometimes enhanced by very intricate interactions with certain of the milk constituents. The law prohibits the use of more than 0.5 percent of these stabilizers, but few manufacturers use even that much. Excessive amounts will cause technical difficulties and produce a body that is "gummy" and "heavy" and thus not very refreshing.

Merits of higher mix processing temperatures

Heat treatment is a more subtle way of reducing the amount of free water. This enhances the natural ability of some milk proteins to bind water.

Experiments with this method have been conducted in the Depart-

Joseph Tobias, Associate Professor of Dairy Technology in the Department of Food Technology, has been at the University of Illinois since 1948, having previously been at the University of Georgia.

ment of Food Technology. Equipment was used that could raise the temperature to anywhere between 200° and 305° F. in only 6 seconds and cool in 6 seconds. Such controlled heating and cooling is most valuable in studies of the physical-chemical properties of milk constituents.

The effects of heating were measured by determining viscosities, which, in general, increased with the intensity of heating. The influence of heat on viscosity became greater as the solids content was increased.

Ice cream had a much better consistency when the mix was processed at 240° than when it was processed at 200° F. This would be expected, considering the effect of heat on viscosity.

Heat also affects the flavor of the mix, and this may be carried over into the ice cream. Some of the amino acids in milk contain sulphur, which under the influence of heat produces compounds that impart a cooked or custard flavor. A small amount of cooked flavor is unavoidable and is imparted even by the compulsory pasteurization process, but an excessive amount would be undesirable.

Fortunately, as heat becomes greater the intensity of cooked flavor does not increase as fast as the "bodying" effect. It is therefore possible to choose a processing temperature that has little effect on flavor and considerable effect on body and texture of the ice cream. A panel of judges could not distinguish by tasting whether an ice cream had been heated to 240° F. and quickly cooled, or whether it had been processed at 160° F. for 30 minutes. The latter is the required pasteurization treatment in Chicago and is used in most Illinois plants.

The question immediately arises as to whether bacteria are as effectively killed by the quick heating and cooling as by holding the mix at a lower temperature for a longer time. An answer to this question can be found in the chart, which shows a series of time-temperature combinations that give equivalent destruction of a selected heat-resistant bacterium. Also shown are the best available data on the thermal destruction of the organism which causes tuberculosis. It is clear that the proposed conditions provide a sizable safety margin.

Before any time-temperature relationship can be used in ice cream manufacture, a Public Health regulatory agency must give official approval.

Continuous processing

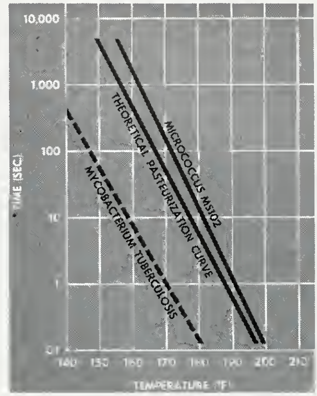
With our increased understanding of the way heat affects the chemical and physical properties of the mix, continuous processing becomes feasible. Engineering know-how and necessary equipment are already available for processing the mix continuously and thus increasing the economy and efficiency of production.

Every other step in ice cream manufacture is now automatic or can be made so. Blending the mix ingredients can become automatic by using flow meters for liquid ingredients and making the dry ingredients cold-soluble or pre-solubilized so that they can be metered like the other fluids.

Continuous freezers are already being widely and successfully used. For years, fruits, nuts, and candy have been continuously injected into the semi-frozen ice cream. Automatic packaging has reduced unit cost as well as improved sanitation.

Progress is being made with continuous hardening either by contact with cold plates or by forced air tunnels at extremely low temperatures. It is now possible to harden ice cream in about 1 hour instead of the conventional 24 hours required previously.

Thus mix making is the only step left to be made continuous, and much progress is being made in that direction. Continuous flow of liquids makes it possible to use an engineering principle of "regeneration," whereby a cold mix partially cools the hot mix, which, in turn, partially warms the former. This saves steam as well as refrigeration, and allows processing of larger volumes in a given space than is possible with the batch process.



Time and temperature requirements for equivalent destruction of two bacteria. Also time and temperature combinations equivalent to the federal pasteurization requirement of 155° F. for 30 minutes. (Data for mycobacterium tuberculosis from Oldenbush, Frobisher, and Shrader.)

Other problems

It is not to be implied that continuous processing is a cure-all for every problem encountered in the manufacture of ice cream. Some problems will still remain unsolved, posing a challenge to investigators. A good example is a defect that causes the ice cream to shrink away from the sides of the container. At first glance it appears as though the container was not filled properly, but in reality it was and then the ice cream began to shrink. Many of the factors involved are known, but still the defect is observed from time to time, and to compound the problem, it often disappears before the cause can be ascertained.

With the help of knowledge gained from the physical and biological sciences, most of the problems will eventually be solved. Such advances should make it possible to continue producing a superior product at a reasonable cost.

Calcium Needs of Adults Are Re-examined

JULIA O. HOLMES, BEULA V. McKEY, and GERTRUDE L. BORCHERS

After a lapse of many years, the Nutrition Research group in the Department of Home Economics is again studying the adult's requirement for calcium.

Earlier data on this subject had been obtained between 1941 and 1951 by the Nutrition Research group, the Division of Animal Science, and the Department of Physiology. The National Research Council used the data in formulating current recommended allowances for calcium. To meet these allowances, upwards of 2 cups of milk a day for adults have been considered necessary.

Present requirement questioned

This milk requirement is now being challenged. Some investigators believe that adults have a very low calcium requirement and don't need milk — at least not for its calcium content.

Several observations form the basis for this opinion: Many races have existed, presumably for centuries, on low-calcium diets. Prisoners in Peru, habituated to their calcium-low prison diet, had calcium requirements only one-third as great as the adults studied at the University of Illinois. And when prisoners in Norway had their adequate calcium allowance cut in half, they slowly passed from a stage in which they lost from their bodies more calcium than they were eating, to a stage in which they utilized the food calcium more efficiently and their losses were no greater than their intake. Not all prisoners, however, adapted to their low-calcium diets.

Questions about adaptation

It is this problem of adaptation that concerns home economists. They want to know (a) if adults reared on liberal-calcium diets can adapt to diets containing little, if any, milk; (b) the time required for adaptation; (c) the amount of calcium lost from the body during the process of adaptation; (d) whether phosphorus and magnesium are lost along with calcium; and (e) whether these losses are replaced if and when the person begins to use his mineral allowances more efficiently.

Six men on low-calcium diet

To answer these questions, six men graduate students were housed in the Home Economics Diet Research House and fed a diet that supplied only 0.4 gram of calcium a day instead of the 0.8 gram recommended by the Food and Nutrition Board of the National Research Council. The phosphorus content of the diet was adequate as judged by the Food and Nutrition Board.

Although the diet contained little milk, it included other commonly eaten foods. These consisted of five different groups, each group being repeated every 5 days for 75 days. The foods were selected for their versatility in menus — apples, for example, could be served as sauce, salad, or dessert.

The menus contained the conventional high protein food; vegetables; potatoes, rice, or spaghetti; salad; and dessert. The meats used were beef, fresh ham, chicken, and tuna fish. All were freed of visible fat, ground, and thoroughly mixed. Other foods were chopped, diced, or mashed. Portions of every food were carefully weighed. This procedure insured that every portion of a certain food would have the same chemical composition. Pyrex glassware was used for mixing and for cooking. Each person's food was cooked separately, in pyrex skillets, casseroles, or ramekins, and the foods were eaten from the dishes in which they were cooked.

The entire procedure of preparing, mixing, weighing, cooking, and serving the foods involved meticulous work. It required the services of two full-time dietitians and two half-time students.

When a food was weighed for the men, two portions of identical composition and weight were set aside and sent to the laboratory to be analyzed for calcium, phosphorus, and magnesium. Kidney and intestinal excretions were collected every day by the subjects and also sent to the laboratory for analysis. The differences between the amounts of calcium, phosphorus, and magnesium eaten, and the amounts excreted represented the amounts retained in the body.

Early conclusions

Most of the analyses for calcium and phosphorus have been completed, and those for magnesium are well underway. We can therefore draw a few tentative conclusions.

When the six men first started the low-calcium diet, they lost more calcium than they were eating. Presumably some of this calcium came from the skeleton. As the experiment progressed, the men tended to excrete less and less calcium — that is, they were absorbing more calcium from their food.

Even though the phosphorus content of the diet met the recommended allowances, the men at first tended to excrete more phosphorus than they ate. By the end of the study, however, all but one were in phosphorus equilibrium; that is, excretion equaled intake.

It is expected that more detailed reports of this study will be given in future issues of Illinois Research.

Julia O. Holmes is Professor of Nutrition; Beula V. McKey, Assistant Professor of Nutrition; and Gertrude L. Borchers, Assistant Professor of Home Economics. Helen F. Johnson, Frances LaFont, Delia Navarrete, Charlotte K. Rhodes, and Hon Lin Hwong also worked on this study.

Child-rearing attitudes of German and American mothers

DON W. RAPP

IT HAS LONG been accepted that German parents are stricter and more authoritarian in bringing up their children than are American parents, although little or no research has been done on this subject until recently.

Now that West Germany has a government and a technological society similar to ours, a question arises as to the Germans' present child-rearing attitudes. Have these attitudes changed with the changing times or do they still reflect the authoritarianism historically attributed to German parents?

A reflection of total culture

Since parents have the responsibility for socializing their young, their child-rearing attitudes are an important aspect of any culture. How parents train their children, as well as what they teach, is bound to reflect both the standards of their culture as a whole and of their social class in particular. The mother's attitudes are especially important. In our own country and in most countries of Western Europe, the mother usually has the chief responsibility for socialization, particularly during the child's first few years.

Attitudes of 248 mothers tested

Many studies have recently been made of mother-child relationships. The present study involved 248 mothers, half from Baden, West Germany, and half from Florida.

All the mothers, both German and American, were Caucasian, Protestant, and from intact homes; they reported parents, husband, and themselves to be citizens of their respective countries; and they had at least one preschool child.

Both groups were divided into upper, middle, and lower social classes. Each German mother was paired with an American mother. Of the 124 pairs, 86 were matched exactly on the basis of social class, age of mother in 5-year intervals, and number of children in the family. The others were matched for social class and as closely as possible for the other two categories.

The Shoben Parent Attitude Survey was used. Five scores were obtained for each woman: a total score; three subscale scores indicating dominance, possessiveness, and ignoring; and a fifth one, measuring dogmatism. A high total or subscale score indicates high restrictiveness and control in child-rearing attitudes; a low score, the opposite.

German mothers more restrictive

The German mothers, as a group, had higher total scores than the American mothers, indicating that German mothers were more authoritarian and dogmatic than were the American mothers.

A similar difference between German and American mothers was found in each of the three social classes. That is, the German mothers in the lower class were more restrictive than their American counterparts, and the same thing was true of the upper and middle classes.

Differences within each culture

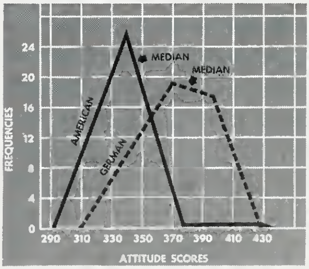
A comparison of the three classes within each country gave some interesting insights into the class structures of America and Germany. Upper class scores in Germany were compared with middle class scores and with lower class scores; and middle class and lower class scores were also compared. The same thing was done with American scores.

In both Germany and America, upper and middle class scores were quite close together, indicating that these two classes had similar child-rearing attitudes in both cultures. In each country, the lower class mothers had more restrictive and controlling attitudes than upper and middle class mothers. However, the disparity between the lower class on the one hand and the upper and middle classes on the other hand, was much greater in Germany than in America.

It is not surprising that class differences, as expressed by child-rearing attitudes, should be greater in Germany, since Germany has historically had a more authoritarian ideal and a more rigid class structure. American democratic and equalitarian ideals would be expected to minimize class differences.

Would broader sample have made a difference?

Somewhat different results may have been found if mothers from all over Germany and the United States had been included in the study. However, the differences between the two groups were so pronounced that they seemingly could not be ironed out by any possible regional variations in either country.



Distribution of German and American scores. Although American scores covered a wider range, most of them were much more closely grouped than were the German scores.

Don W. Rapp is Assistant Professor of Home Economics in the Division of Child Development. Interested in the subject of this research because of his own German ancestry, he undertook the study while doing graduate work in Germany.

A New Disease of Illinois Cottontails

D. H. FERRIS, R. D. LORD, and D. L. HUXSOLL

Although the cottontail is not regarded as an agricultural animal, game biologists estimate that more rabbit may be eaten than deer, which now rates as our third most popular red meat species. Since the ubiquitous rabbit seems to be adapting to our rapidly changing rural environment and is in close contact with people and domestic animals, its health is of interest and importance.

Illinois led the nation in human tularemia for several years, but effective game management has greatly reduced the prevalence of this disease. We have not found evidence of tularemia in the necropsy or examination of over 2,000 rabbits during the past 4 years.

In recent years, however, a new disease of cottontails has been reported. It has been investigated in the College of Veterinary Medicine since 1958.

Signs and symptoms

This new disease resembles human poliomyelitis in some respects, although so far it has not been found infective for man or other animals. Like polio in man, the disease causes paralysis and sometimes death. The paralysis begins as a "wry neck," or torticollis, usually to the left (Fig. 1). Movements at this stage are not well coordinated, as the animal runs and even spins rapidly to the left. The paralysis next affects the hind legs and then extends throughout the body until the animal is completely paralyzed. As in polio, some individuals apparently recover with neck and limbs afflicted, but most of the infected rabbits die.

Some diseased rabbits that had been brought to the Veterinary Medicine laboratory had a temperature of 105° F. during the acute stage. In spite of the paralysis, they continued to eat as long as they could reach food and water.

Laboratory findings

In the early stages a widespread hemorrhage occurs beneath the brain linings, sometimes extending into the brain (Fig. 2). Later the brain lining becomes inflamed, though no pus is formed, and the number of phagocytic scavenger cells greatly increases. Sometimes the nerve coverings and even the nerve tissue of the brain and spinal cord are destroyed. Cause of the disease is probably a virus.

Young cottontails and domestic rabbits contracted the disease after laboratory inoculation with brain materials from rabbits in early stages of the disease (Fig. 3). Attempts to transmit the disease to other species were unsuccessful.

Disease not widely reported

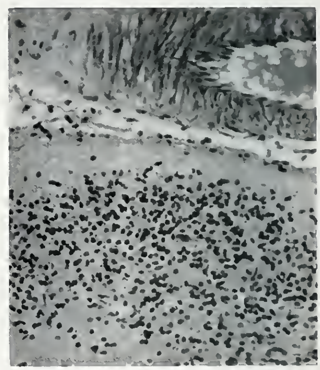
The first cases reported were from the Champaign-Urbana area and from Allerton Park, about 25 miles away. Later, after biologists and hunters had been alerted, a few cases and descriptions were reported elsewhere in the state. Thus far sick animals have been observed only during the warm months. This fact, together with the failure to transmit the infection by contact, suggests that the disease might be arthopod-borne.

Young rabbits appear to be more susceptible than mature ones. Since animals handicapped with paralysis and incoordination would be easy prey to predators and would not live long in the wild, it is easy to understand why this disease was not previously reported.

More experimental work is being done to develop a diagnostic test, learn more about the causative agent, and determine if the disease presents any danger to other animals.

D. H. Ferris is Associate Professor of Veterinary Pathology and Hygiene and of Veterinary Research; R. D. Lord, Research Associate, State Natural History Survey; D. L. Huxsoll, Assistant in Veterinary Medicine.

A young cottontail suffering from a natural case of the disease. (Fig. 1)



Dark spots are lesions in the white matter of the brain. Similar lesions may appear in the gray matter. (Fig. 2)

Domestic rabbit that developed the disease through inoculation. (Fig. 3)

RESEARCH IN BRIEF

The Rat's Amino Acid Requirements as a Standard for Evaluating Protein

Various attempts have been made in the Department of Animal Science to evaluate the nutritive value of proteins from their amino acid content.

About 15 years ago H. H. Mitchell computed a "chemical score" of protein based on the most limiting amino acid in whole egg protein. Later Dr. Mitchell developed a modified essential amino acid index, retaining whole egg protein as the standard.

Ideally the essential amino acid requirements of the growing rat should serve as a better standard for calculating amino acid indices. For this purpose, we have redetermined these requirements and have studied the correlation between the amino acid content of proteins and their biological value.

A high correlation coefficient (0.919) was found between biological value and the chemical score calculated on the basis of these amino acid requirements. The correlation coefficient between biological value and the modified essential amino acid index, based on amino acid requirements, was essentially the same although the standard error of estimate was much lower. When the geometric mean of only the limiting essential acids in each protein was used in the calculation, an equally good correlation (0.9) with biological value was obtained. — *P. B. Rama Rao and B. Connor Johnson*

Cold Storage of Pine Seedlings for Spring Planting

If pine seedlings could be lifted from the nursery bed in late fall or early winter and placed in cold storage, the spring "rush" period could be avoided and permanent labor could be better utilized. The Forestry Department has therefore conducted a 2-year study to find the optimum time for lifting loblolly pine seedlings from the nursery bed for cold storage.

One and three-quarter million pine seedlings can be stored on carts such as this one in a 23-by-50-foot cold-storage room.

Seedlings were lifted from the nursery bed each month from October to February during the fall and winter of 1958-59 and of 1959-60. The seedling roots were packed in moist sphagnum moss and stored at 38° F. until the following spring, when they were field-planted. At planting time, seedlings lifted early in the fall and placed in cold storage were dead and covered with mold. There was no mold on seedlings that were lifted in early winter and judged to be dormant when they were packed for cold storage.

We concluded that field survival of cold-storage, loblolly pine seedlings is influenced more by the physiological condition of the seedling at time of storage than by the storage conditions. Pine seedlings can be lifted from the nursery bed in southern Illinois as soon as the plants are hardened and dormant, usually about the first of December. — *A. R. Gilmore*

Influence of Soil and Site on Growth of Pine Plantations

Large acreages of shortleaf and loblolly pine are being planted in southern Illinois to convert abandoned fields to forests. In general, fields are abandoned because they are badly eroded and of low soil fertility. Pine seedlings planted on such denuded land cannot make their best potential growth. Small differences in degree of erosion or in fertility may thus mean the difference between profit and loss in growing pines as a forest crop.

For this reason, the Department of Forestry has begun a study aimed

Using soil borings and information obtained from the soil-plantation survey, a forester will be able to predict the growth of pine planted on this old field.

at measuring the effects of soil and site on tree growth. The study, which was begun in the spring of 1960, includes pine plantations in the 20 southernmost counties in the state.

Laboratory analyses of samples taken from each horizon of the soil profile within a plantation will give us important data about the productivity of a soil. Height and diameter measurements of all trees within the plot will indicate how well the trees are growing on a particular site. Put together, these data will enable us to predict how productive a site may be for future plantations of shortleaf and loblolly pine. — *G. E. Metcalf*

Yeast for Feed Is Produced From Cheese Whey

Over 12 billion pounds of whey is produced in the United States every year. A very large portion of it is wasted and only a very small portion put to use.

In some European countries where small cheese plants are located close to the farms, whey is fed directly to the farm animals. The addition of small amounts of whey to the feed has been successful. Large amounts, however, may cause digestive disturbances because of the high lactose content of the whey.

Obviously, increasing the nutritional value of whey would add to its potential usefulness. To accomplish this aim, methods of yeast growth in whey have been studied in the Department of Food Technology.

Trichosporon cutaneum was selected as the test organism. It has the advantage of utilizing lactose and its components, glucose and galactose, at the same rate. Further, the major product after utilization of these sugars is yeast cell material, for *T. cutaneum* is non-fermenting and does not produce side products such as alcohol or glycerol. Thus a higher yield of yeast cells can be obtained than with some other yeast organisms.

Although whey alone supported the growth of *T. cutaneum*, the addition of ammonium sulfate and corn steep liquor, at levels of 0.1 percent, increased the organism's rate of growth and the efficiency with which it converted lactose into cell material.

Under optimum growth conditions, cells could double their dry weight in 2 hours. When a 1-percent inoculum of *T. cutaneum* was used in a batch growth system, the total growth period was 12 to 24 hours, depending on the dilution of whey. Processing times could be shortened by using larger inocula or by using a continuous growth system.

A simple continuous propagator was developed from regular laboratory equipment. With this propagator, 3.6 to 3.8 grams of dry yeast cells per 100 milliliters of whey could be produced within 3 to 3.5 hours of holding time. The organism was readily removed from the spent whey by centrifugation. Chemical analysis of the product indicated that it would be a valuable nutrient because of its high concentration of amino acids and vitamins. The solution remaining after centrifugation contained comparatively small amounts of organic matter and would therefore be easier to dispose of than the original whey. — *Cavit Akin*

The Search for Resistance to Brown Stem Rot of Soybeans

Brown stem rot of soybeans (*Cephalosporium gregatum*) was discovered in central Illinois in 1944. Ever since then, it has been a major problem in the research program of the U. S. Regional Soybean Laboratory on the Urbana campus. An important phase of this work has been the search for a source of resistance to the disease.

The brown stem rot organism readily invades susceptible plants from infested soil. A plot of land on the Agronomy South Farm has been cropped continuously with soybeans to build up soil infestation with this organism and to provide a testing ground for evaluating soybean strains. Even with this much infestation, some susceptible plants escape infection. Hence, all disease-free plants must be retested to determine whether they are truly resistant or whether they are "escapes" from the disease.

The first group of soybeans to be tested at Urbana was the varietal collection, consisting of early-, medium-, and late-maturing varieties. Among the varieties grown commercially in Illinois, Blackhawk and Hawkeye (early varieties adapted to the northern areas of the state) had the greatest number of disease-free plants. Clark and Perry, which are late varieties adapted to the southern half of the state, had the fewest disease-free plants. Progeny tests, however, showed that all uninfected plants were "escapes" rather than resistant types.

When a susceptible variety such as Lincoln was planted on or before May 20, it developed heavy infection; planted after June 20, however, it developed little or no infection. Unfortunately, soybeans planted after June 20 generally yield

much less than those planted around May 20, thus nullifying the gain that would be made by escaping brown stem rot. Late planting therefore is not the way to control this disease.

In addition to the named varieties, about 2,000 introduced soybean strains from the germ plasm collection of the Laboratory have been evaluated. One of these strains, P.I. 84946-2, from Korea, yielded a very high proportion of disease-free plants. Progenies from these plants were tested and reselected for 5 years. This selection failed to yield a line that was 100 percent resistant; the lines, however, continued to yield 25 to 50 percent disease-free plants. Since control rows of susceptible varieties throughout this 5-year period were 100 percent infected, this introduction appears to be a significant approach to resistance. Further investigations are being made to learn more about this type of resistance and to determine how it can be transferred to adapted varieties by hybridization.

In 1955, another approach was made to the problem of finding resistance to brown stem rot. Seeds of six varieties (Adams, Clark, Blackhawk, Harosoy, Hawkeye, and Perry) were irradiated with thermal neutrons in an attempt to induce gene mutations that would produce resistant plants. This material has been carried through 4 years of testing. Since none of the selections have produced disease-resistant progenies, it seems evident that the desired mutation has not occurred. — *D. W. Chamberlain and R. L. Bernard*

Storing High-Moisture Corn in Lined Cribs or Bins

The possibility of storing high-moisture corn in ear-corn cribs and shelled-corn bins is being investigated by the Department of Agricultural Engineering.

In cooperation with a manufacturer of packaging materials, a corn crib has been lined with a moisture-proof material made of paper coated with a layer of polyethylene film and aluminum. The material, nearly 1/10 inch thick, has the rigidity of heavy cardboard and can be easily applied to the inside of a bin. Held in place with nails, screws, or bolts, it can be cut, creased, or bent into almost any shape.

This material appears to have the advantage of remaining in place when the grain is removed from the bin. Other lining materials have failed to do this and have caused considerable difficulty with augers and other unloading equipment.

Observations are being made on the ease of installing the material, the keeping quality of the stored grain, and the material's resistance to weathering as well as to damage from the high-moisture corn. — *Gene C. Shove*

Experimental Infection of Swine With *Leptospira ballum*

Although *Leptospira pomona* is responsible for most cases of leptospirosis in swine, many other species of leptospires may also cause this disease. Recently the susceptibility of swine to a culture of *Leptospira ballum* 232 was studied in the College of Veterinary Medicine.

The organism used in preparing the culture had been isolated from a hog-nosed snake in southern Illinois. Eighteen cross-bred feeder pigs weighing about 60 pounds were injected under the skin with 2 milliliters of the culture. Each injection contained about 1.2 billion leptospires.

Six control pigs (not injected) were placed in contact with the injected pigs 16 days after the start of the experiment. Three other control pigs were not exposed to the disease.

Five and nine days after inoculation, sterile blood samples were obtained for culture, blood counts, and blood smears. No leptospires were isolated from the blood. Infected and control pigs showed no significant difference in blood counts. Two pigs had rectal temperatures of 105° and 105.5° F. 24 hours after inoculation. One had a temperature of 105° F. 48 hours after inoculation.

Serum from an infected pig gave an incomplete reaction for *L. ballum* at the 1:10 dilution 5 days after inoculation. A maximum titer of 1:1000 was shown by serum from a pig 9 days after inoculation. Three months after inoculation, serum from one pig still gave a reaction in the 1:10 dilution as measured by the agglutination-lysis test; sera of all other surviving infected animals, however, were negative.

Guinea pigs were inoculated with samples of urine from pigs that had been injected with *L. ballum* and from pigs that had not been injected but had been exposed. Inoculations were into the peritoneal cavity. After 2 weeks, none of the guinea pigs showed signs of infection according to the agglutination-lysis titer.

At autopsy no leptospires were isolated from the livers, kidneys, or spleens of infected pigs. Nor were any leptospires demonstrated in sections of kidney tissue stained by the Levaditi silver stain. However, many leptospires were observed in the kidney of a guinea pig that died 12 days after being inoculated with heart blood from a guinea pig infected with *L. ballum* 232.

The only diseased tissues found in infected pigs were in the liver and kidney. The primary lesion was congestion of the cortex (outer part) of the kidney. Occasionally the tubular tissues in the kidney were dead or diseased. Concentrations of lymphocytes (a type of white corpuscle) were sometimes found in the spaces between the tubular tissues. Some of the liver tissue was also dead or diseased; and some of it had been infiltrated with lymphocytes. Infected pigs killed 90 days after inoculation were apparently normal.

These results suggest that feeder-age swine exposed to *Leptospira ballum* 232 by the subcutaneous route may be expected to develop antibodies against the organism and to show evidence of disease in their body tissues, but that they do not shed the organism in their urine. — *George T. Woods*

FARM BUSINESS TRENDS

"The price of meat never changes at the store where we buy our meat. Why doesn't it come down when prices of livestock fall?" This statement is often made and the question asked in meetings of livestock producers.

Farmers have a right to be concerned about the flexibility of meat prices. If prices don't flex, the free market can't work properly. However, while retail meat prices may not change as much as some of us think they should, they are adjusted up and down in response to changes in livestock prices.

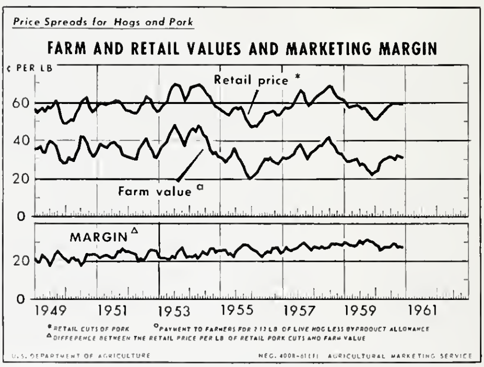
There may be some retailers who never change their prices. Certainly few change them from hour to hour or day to day, as the livestock market changes. Rather the changes in retail prices are made from week to week. This can be affirmed by any price-minded shopper who compares prices in different stores and at different times.

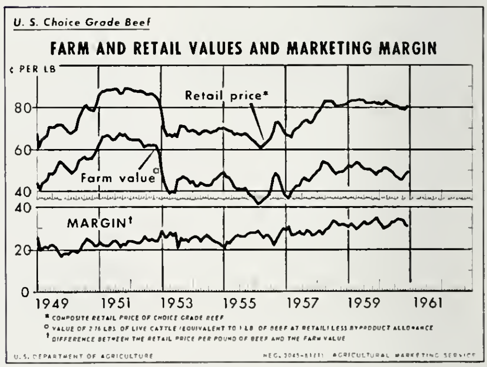
Many research workers have studied the relationship between retail meat prices and the value of live animals. All have found a close correlation.

The U. S. Department of Agriculture recently published a study of farm and retail values and marketing margins for beef and pork. Some of the results are shown in the two charts below. They cover a period of 12 years, 1949 through 1960.

A careful study of these charts reveals some important facts:

1. With few exceptions, retail prices of meat and the farm value of live animals generally went up and down together, from month to month and from year to year.
2. On a month-to-month basis, the marketing margin usually shrank when prices rose, and swelled when prices declined. This seems to indicate that there is more competition among processors and distributors when supplies are scarce than when they are abundant. It puts the livestock producer in a double pinch when market supplies are temporarily increased.
3. The marketing margin gradually increased from around 20 cents a pound in 1949 to around 30 cents in 1960, mainly because of increasing labor costs. The persistent rise in marketing margins has widened the spread between retail prices and farm value, and has been a major factor in the cost-price squeeze on farmers in the past 10 years. — *L. H. Simerl*





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Fall, 1961

ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

IN THIS ISSUE

Corn harvested with a high moisture content has been shown to be a satisfactory feed for dairy cattle (page 3).

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ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

CONTENTS

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RESEARCH IN THE DEPARTMENT OF HOME ECONOMICS

seeks fundamental information about fiber, food, shelter, child development, and family economics which can ultimately enhance and extend human life. Our program is balanced between basic studies which seek to *establish* principles, and applied research which tests *applicability* of principles to a specific problem or situation.

Research of the department has been enriched through cooperation or consultation with other departments in the College and the University — particularly agricultural economics, food technology, horticulture, animal nutrition, mechanical engineering, psychology, biochemistry, economics, and physiology.

Twenty-five members of the departmental staff are currently engaged in 12 experiment station projects. Other research is financed by contract and gift funds or special funds for graduate work. Among current investigations are studies of chemical and physical properties of starch as correlated with its behavior in food products; preservation of foods by home freezing and enzymatic interactions in home-frozen food; magnesium and calcium interrelationships in human nutrition; use of non-fat dry milk in quantity food preparation; consumption patterns of rural families; cost, performance, and upkeep of window types; clothing comfort as affected by fiber content; fabric behavior under repeated small magnitude stresses; effects of nursery-school group music training on later musical performance and interest; and factors contributing to childhood obesity.

Our research serves to enrich the entire educational program in home economics. Senior staff members who direct research also do graduate teaching. Extension specialists make research results available to people throughout the state. — *Janice M. Smith, Head of the Department*

After receiving her Ph.D. degree in biochemistry from Illinois, Dr. Smith directed research and graduate study in human nutrition at Pennsylvania State University and later served with the War Food Administration. She returned to Illinois as Head of the Foods and Nutrition Division, accepting her present position in 1950.

The nutritive value of HIGH-MOISTURE CORN for DAIRY CATTLE

Experimental cows were housed in a stanchion barn.

K. E. HARSHBARGER

ENOUGH EVIDENCE is now in, from both farmers and research workers, to show that high-moisture corn can be effectively preserved in airtight silos and other structures.

Little has been known, however, about its nutritive value for dairy cattle. In one year's trials, reported in the summer, 1959, issue of ILLINOIS RESEARCH, dairy cattle used high-moisture corn efficiently, but it was no better than regular corn. Since then, further feeding trials have been conducted, including one on the effects of grinding.

Effects of grinding tested

Twelve 615-pound Holstein heifers were divided into two groups to compare the feeding value of high-moisture shelled corn with that of high-moisture ground corn.

The corn (31-percent moisture) had been harvested with a corn combine and stored as shelled corn in a conventional silo. One group of heifers received the corn as it came from the silo. For the other group, the corn was ground in a hammer mill (½-inch screen) before feeding.

Both groups received alfalfa-grass hay on a limited basis — that is, about 1 pound per 100 pounds of live weight a day. Each heifer also received 1 pound daily of a soybean meal-mineral mixture. A hundred pounds of mixture contained 86 pounds of soybean oil meal, 8 pounds of dicalcium phosphate, and 6 pounds of trace-mineralized salt. The rations were fed continuously for 24 weeks.

K. E. Harshbarger received his education at the University of Illinois and is now Associate Professor of Nutrition and Chief of the Nutrition Division in the Dairy Science Department.

Intakes of feed and dry matter were essentially the same for the two groups (Table 1). However, the heifers on the ground corn gained 23 percent more than the others, and also increased more in heart girth and withers. Feed efficiency, as measured by the ratio of live weight gain to 10 pounds of feed dry matter consumed, showed a 23-percent advantage in favor of ground corn.

Heifers on two corns and grain

Eighteen Holstein heifers averaging about 750 pounds were divided into three groups. One group received high-moisture corn (35-percent moisture), which had been harvested with a corn combine and ground with a hammer mill before ensiling. The second group received regular ground corn. The third group was fed a complete grain mixture (No. 48), containing corn, oats, wheat bran, soybean oil meal, steamed bone meal, limestone, and salt.

Corn rations were supplemented with alfalfa-grass hay and the soybean meal-mineral mixture described above. The grain ration was supplemented with alfalfa-grass hay only. Each ration was fed continuously for 24 weeks.

Heifers gained faster on both kinds of corn than on the complete grain mixture (Table 2). Similarly, feed efficiency, as measured by weight gain for each 10 pounds of feed dry matter consumed, was higher for the two corn rations than for the grain ration. The low response to the complete grain mixture is due to the fact that 40 percent of the mixture was wheat bran and oats, which have less feeding value than corn.

Cows fed three kinds of corn

Six Holstein cows were fed high-moisture ground corn which had been harvested with a corn combine and stored as shelled corn (32-percent moisture) in a conventional silo. It was ground daily for feeding.

Another group of six Holstein cows were fed high-moisture ground

Table 1. — Results of Feeding High-Moisture Shelled Corn and Ground Corn to Heifers

Items	Ration groups	
	H-M shelled corn (31%)	H-M ground corn[a] (31%)
Daily feed intake, lb.		
Alfalfa hay	8.97	8.99
Corn	6.24	6.26
Soybean meal-mineral mix	1.00	1.00
Daily dry matter intake, lb.		
Alfalfa hay	7.75	7.76
Corn	4.30	4.31
Soybean meal-mineral mix	.93	.93
Total	12.98	13.00
Daily weight gain, lb.	0.96	1.18
Heart girth increase, in.	6.38	7.46
Withers increase, cm.	10.3	10.8
Feed efficiency		
Weight gain per 10 lb. of feed dry matter, lb.	.74	.91

[a] This corn was stored as high-moisture shelled corn and ground with hammer mill daily for feeding.

ear corn that had been harvested with a corn picker and ground with a burr mill at the time of ensiling. The corn and cob meal contained about 37-percent moisture because the cobs were much higher in moisture than the kernels. A third group received regular ground corn.

All rations were supplemented with alfalfa-grass hay, corn silage, and soybean meal-mineral mixture. Each ration was fed continuously for 13 weeks.

Results are presented in Table 3. Average daily intakes of feed and dry matter varied among groups because individual cows differed in roughage consumption, and the concentrates were partially adjusted for level of production. The amount of corn fed per pound of milk produced was adjusted for differences in moisture content. No adjustment was made, however, for the cob in the high-moisture ground ear corn.

Cows on the high-moisture ground shelled corn produced the least milk a day, but they were the most persistent in production. In 13 weeks, their production dropped only 16 percent, as compared with 28 percent and 30 percent for cows on the other two rations. They also gained the most weight during the 13 weeks, indicating that adequate feed energy was available for milk production.

Feed efficiency, as measured by pounds of milk produced per pound of dry matter, was lowest for the high-moisture ground ear corn ration. This result is to be expected, because the cob has a lower feeding value than the grain.

Cows on two corns and grain

In another trial, 15 Holstein cows and 3 Brown Swiss cows were assigned to three ration groups. One ration contained high-moisture corn (35-percent moisture) that had been harvested with a corn combine and ground with a hammer mill before ensiling. The second contained regular ground corn; and the third, the complete grain mixture (No. 48) previously described.

Each ration also contained alfalfa-grass hay and the soybean meal-mineral mixture already described. Rations were fed continuously for 12 weeks.

Feed intakes were controlled to give all three groups about the same amount of dry matter daily (Table 4). Cows on the grain mixture produced slightly less than the other cows, and also lost more weight.

High-moisture corn about equal to regular corn

In these trials, as in the earlier ones, high-moisture corn gave excellent results, but was not superior to regular corn. For maximum feeding value, high-moisture corn should be ground.

Table 2. — Results of Feeding High-Moisture Corn, Regular Corn, and a Grain Mixture to Heifers

Items	Ration groups		
	H-M corn[a] (35%)	Regular corn (14%)	Grain mixture
Daily feed intake, lb.			
Alfalfa-grass hay	10.96	10.89	10.68
Corn	7.99	6.66	.....
Soybean meal-mineral mix	1.00	1.00	.....
Grain mixture	.....	.....	8.13
Daily dry matter intake, lb.			
Alfalfa-grass hay	9.65	9.59	9.40
Corn	5.21	5.69	.....
Soybean meal-mineral mix	.90	.90	.....
Grain mixture	.....	.....	7.08
Total	15.76	16.18	16.48
Daily weight gain, lb.	1.41	1.48	1.30
Heart girth increase, in.	6.38	6.98	6.27
Withers increase, cm.	6.87	7.20	7.35
Feed efficiency			
Weight gain per 10 lb. of feed dry matter, lb.	.89	.91	.79

[a] High-moisture corn was stored in silo as ground corn.

Table 3. — Results of Feeding High-Moisture Corn and Regular Corn to Milking Cows

Items	Ration groups		
	H-M shelled corn[a] (32%)	H-M ear corn[a] (37%)	Regular corn[a] (13%)
Daily feed intake, lb.			
Corn silage	35.62	38.67	36.76
Alfalfa-grass hay	13.91	15.02	15.25
Corn	14.63	19.10	12.44
Soybean meal-mineral mix	2.00	2.05	2.02
Daily dry matter intake, lb.			
Corn silage	11.53	12.52	11.90
Alfalfa-grass hay	12.29	13.27	13.47
Corn	10.00	11.95	10.85
Soybean meal-mineral mix	1.83	1.88	1.85
Total	35.65	39.62	38.07
Daily milk production			
Initial level	48.75	56.72	57.18
13-wk. av. milk yield, lb.	42.62	45.62	47.57
13-wk. decline, pct.	16.0	28.0	30.0
Fat-corrected milk (4%) yield, lb.	40.45	45.70	47.18
Av. body weight change, lb.	+83.6	+36.8	+49.0
Feed efficiency			
Milk per lb. of feed dry matter, lb.	1.20	1.15	1.24
Fat-corrected milk per lb. of feed dry matter, lb.	1.13	1.15	1.24

[a] High-moisture shelled corn and regular corn were ground before feeding. High-moisture ear corn was stored as ground ear corn in silo.

Table 4. — Results of Feeding High-Moisture Corn, Regular Corn, and Grain Mixture to Milking Cows

Items	Ration groups		
	H-M corn (35%)	Regular corn (14%)	Grain mixture
Daily feed intake, lb.			
Alfalfa-grass hay	30.22	29.60	29.24
Corn	18.71	13.66	.....
Soybean meal-mineral mix	2.00	2.00	.....
Grain mixture	.....	.....	15.40
Daily dry matter intake, lb.			
Alfalfa-grass hay	27.01	26.46	26.13
Corn	12.19	11.78	.....
Soybean meal-mineral mix	1.80	1.80	.....
Grain mixture	.....	.....	13.33
Total	41.00	40.05	39.46
Daily milk production			
Initial level, lb.	54.92	55.48	55.76
12-wk. av. milk yield, lb.	50.56	49.96	48.20
12-wk. decline, pct.	21.2	23.3	28.2
Fat-corrected milk (4%) yield, lb.	47.63	48.08	46.92
Av. body weight change, lb.	−3.5	−1.6	−15.8
Feed efficiency			
Milk per lb. of feed dry matter, lb.	1.23	1.25	1.22
Fat-corrected milk milk per lb. of feed dry matter, lb.	1.16	1.20	1.19

The Flow of Feed Grains Between Regions

G. G. JUDGE and Y. H. CHUANG

How much feed grain (corn, oats, barley, sorghum grain, wheat, and rye) is consumed by each state or region in a year? How much does each state or region import or export? What are the volume and the direction of flow between each possible pair of states or regions? What is the total cost of transporting feed grains?

These and other related questions should be of interest to anybody engaged in the production or distribution of feed grains. They are currently being analyzed in the Department of Agricultural Economics.

Fairly reliable figures are available for feed-grain production and grain-consuming animal units in a state. Only fragmentary data are available, however, on the consumption of feed grains by states or regions and on the flow between regions.

To get more information on these subjects, we first divided the United States into 37 regions, each consisting of one or more states (see map). The relationship between the price of feed grain and its consumption by livestock during the 1957-58 feeding year was developed for the United States. This was then applied to states or regions to estimate consumption.

Altogether, 129,456,000 tons of feed grains were available and 161,199,000 animal units of livestock and poultry were fed. The analysis of regional consumption and availability revealed 12 surplus regions, 24 deficit regions, and one self-sufficient region (South Carolina).

Shipments estimated

On the map, the lines that start from the surplus (shaded) regions and end in the deficit (unshaded) regions represent the shipments of feed grains that would have satisfied the demands of the deficit regions at the least transport cost. Numbers appearing in the breaks in the line indicate thousands of tons shipped. For example, Illinois would have made the following shipments (in 1,000 tons): to Mississippi and Louisiana, 257; to Alabama, 548; to Florida, 231; to Georgia, 1,450; to North Carolina, 503; to Tennessee, 505; to Virginia, 463; to Missouri, 1,304; and to New Jersey, Delaware, and Maryland, 1,741.

The eastern and southern states were deficit in feed-grain production in 1957-58. Most of their supplies could have come from the north-central region, which was the major surplus area. North and South Dakota could have provided the connecting link between east and west by shipping in both directions. Surplus regions in the west could have supplied deficit regions in the same area.

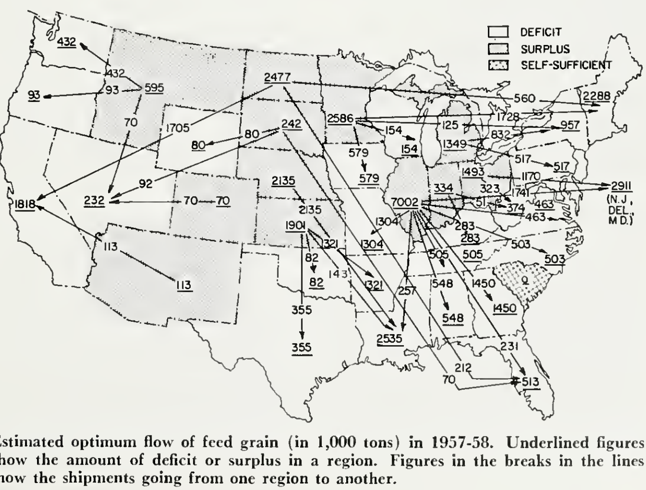
The net interregional trade in feed grains for 1957-58 was estimated at 20,297,000 tons and the total cost for this movement at $311,624,271. Because of transportation costs, prices in the east, south, and far west would be higher than in the north-central states. The price of feed grains was estimated to be lowest in the Dakotas.

Uses of the analyses

An analysis of what could happen under given assumptions may be at variance with what actually happens. The divergence between "what could be" and "what is," however, does indicate possible areas for choice or action.

When better data on the flow of feed grains become available, we can compare them with our estimates of the optimum flow. The estimates can thus be a standard for judging the efficiency of the pricing and distribution system for feed grains.

Through such analyses it will also be possible to determine the changing character of the feed-grain industry and the long-run competitive position of one region compared with another. Such information will help producing firms and public agencies to make decisions and establish policy.



Estimated optimum flow of feed grain (in 1,000 tons) in 1957-58. Underlined figures show the amount of deficit or surplus in a region. Figures in the breaks in the lines show the shipments going from one region to another.

G. G. Judge is Professor, and Y. H. Chuang, Assistant, in Agricultural Economics.

SOYBEAN CURD

Preparation, calcium content, and palatability

WEN-CHIANG LIANG CHIU and FRANCES O. VAN DUYNE

Wen-Chiang Liang Chiu studied at the National Taiwan University in Formosa before coming to Illinois for graduate study. This article is based on her Master's thesis. Co-author Frances O. Van Duyne is Professor of Foods and Head of the Foods and Nutrition Division.

Tofu, or soybean curd, while practically unknown in the United States, has been an important food in the Orient for centuries. Such characteristics as low cost, high protein and calcium content, a desirable texture, and many uses have contributed to its popularity.

It resembles cottage cheese, although there are differences in composition, form and palatability. Perhaps in the future, if more soybean curd becomes available, this nutritious, versatile product will play a greater role in the American diet.

Objectives of the present study were (1) to standardize a small-quantity method of making soybean curd of good quality, (2) to compare the calcium content and palatability of curds prepared from field- and vegetable-type soybeans, and (3) to develop recipes in which soybean curd would be an appetizing and interesting ingredient.

Preparation of soybean curd

There are two main steps in making soybean curd: first, soybean milk is prepared; second, the protein in soybean milk is precipitated by fermentation or by adding acids, salts, or rennet. The precipitating agent most commonly used is one of the calcium salts.

In preliminary experiments, details of preparing the soybean milk and ways of precipitating the curd were investigated. Procedures were based on usual Chinese methods of preparing soybean curd, although they were modified for laboratory equipment and small-quantity preparation.

To prepare soybean milk, 1 pound of dry mature soybeans was washed in cold tap water and soaked in 2 quarts of tap water in the refrigerator overnight. The next day the water was discarded, the beans were rinsed and put into a 6-quart Waring blendor, and 2 quarts of boiling water were added. The mixture was blended for 2 minutes at low speed and transferred to a larger container. Then 3.5 quarts of boiling water were added and the mixture was stirred occasionally for 10 minutes.

The extract was filtered through a triple layer of cheesecloth and the filtrate was saved. Two quarts of boiling water were added to the residue and the mixture was stirred and filtered as before. The filtrates were combined, yielding about 7.5 quarts of soybean milk. The milk was boiled over medium heat for 1 minute.

To precipitate the curd, 6 quarts of boiling soybean milk were cooled to 85° C. and a suspension of gypsum powder (13.8 grams of $CaSO_4 \cdot 2H_2O$ in 50 milliliters of water) was stirred gradually into the milk. Next, the milk was heated over medium heat while being stirred very slowly. It began to curdle within 3 minutes, or when the temperature was brought back to 90° C.

When large chunks of curd formed, they were removed from the whey with a large slotted spoon and put in a sieve lined with cheesecloth. To remove the last portion of curd, the heat was increased. When the mixture boiled, the remaining small pieces of curd would coalesce and float, making removal easy. The time between the appearance of the first small pieces of curd and the completion of coagulation was less than 15 minutes.

Corners of the cheesecloth were folded over and a saucer of proper size was placed on the covered curd. A weight of 860 grams (including the weight of the saucer) was applied to the curd for 10 minutes. Then the saucer, weight, and cheesecloth were removed and the molded curd was weighed and stored in water in the refrigerator.

After the above procedure was developed, it was used to prepare curd from four varieties of soybeans. Two of the varieties, Harosoy and Mandarin (Ottawa), are field-type beans, while the other two, Jogun and Kim, are vegetable-type. Curd was prepared from each variety at least four times.

Testing soybean curd

On the day after preparation, the curd was removed from the water and blotted with paper towels. Then samples were taken for moisture and calcium determinations and for palatability tests.

Each curd was tasted plain and in a salad mixture. For the latter, 1 cup cubed soybean curd, 2 tablespoons chopped green onion, ⅜ teaspoon salt, and 1 tablespoon salad oil were tossed together lightly.

A taste panel of one Chinese and five American judges rated the appearance, color, texture, and flavor of the products. A 5-point scoring system was used in which 5 was equivalent to very good; 4, good; 3, fair; 2, poor; and 1, very poor. Other batches of curd were used in special soybean curd recipes.

Yield, moisture, and calcium content

Mean values for yield, moisture, and calcium content of soybean curd and for moisture and calcium in dry soybeans are given in Table 1. The mean yield of soybean curd obtained from 6 quarts of soybean milk ranged from 860 grams (Kim soybeans) to 952 grams (Jogun soybeans). However, the differences among the yields of the four varieties were not statistically significant. The mean moisture contents of the curds from the four varieties were very similar, varying only from 83.6 to 84.6 percent.

In calcium content, the curd from Jogun beans was significantly higher than the curds from the other varieties. The difference in calcium content between Jogun and Kim was significant at the 5-percent level, while the differences between Jogun and Mandarin and between Jogun and Harosoy were significant at the 1-percent level. Dry Jogun soybeans had more calcium than the other varieties. However, the amounts found in the curds from the other beans did not vary consistently with the amounts present in the beans.

According to the U. S. Department of Agriculture "Agriculture Handbook No. 8," 100 grams of cow's milk contain 118 milligrams of calcium. The mean calcium content of the curd from the four varieties was almost twice as great, amounting to 232 milligrams per 100 grams. These results thus confirm the value of soybean curd, precipitated by a calcium salt, as a source of calcium in countries where soybean curd is accepted readily and where cow's milk is unavailable or very expensive.

Table 1. — Moisture and Calcium Content of Soybeans and Soybean Curd, and Yield of Curd

Variety and type	Dry mature soybeans		Soybean curd[a]		
	Moisture content	Calcium content	Yield[b]	Moisture content	Calcium content
	percent	*mg./100 gm.*	*grams*	*percent*	*mg./100 gm.*
Harosoy (Field)	7.1 ± 0.21	181	886 ± 54.5	84.0 ± 0.57	224 ± 13.5
Jogun (Vegetable) ...	9.4 ± 0.36	254	952 ± 89.5	84.6 ± 0.62	256 ± 9.4
Kim (Vegetable)	7.6 ± 0.16	160	860 ± 55.5	83.6 ± 0.57	232 ± 12.8
Mandarin (Field)	7.3 ± 0.01	217	948 ± 45.0	84.6 ± 0.57	217 ± 6.5

[a] Mean values and deviations for 4 replications.
[b] Amount of curd obtained from 6 quarts of soybean milk.

Table 2. — Palatability Scores for Plain Curd and Curd Salad Mixture

Variety and type	No. of ratings	Mean scores for individual palatability factors				Mean total scores
		Appearance	Color	Texture	Flavor	
			Plain soybean curd			
Harosoy (Field)	23	4.0	4.6	4.3	4.0	16.8
Jogun (Vegetable)...	23	4.0	4.6	4.1	4.1	16.8
Kim (Vegetable).....	24	4.0	4.0	4.3	4.0	16.4
Mandarin (Field)	23	3.9	4.5	3.7	4.2	16.3
			Soybean curd salad mixture			
Harosoy (Field)......	23	4.2	4.8	4.4	4.7	18.0
Jogun (Vegetable)...	23	4.3	4.9	4.2	4.7	18.1
Kim (Vegetable)	24	4.2	4.4	4.6	4.5	17.6
Mandarin (Field).....	23	4.2	4.7	3.9	4.5	17.3

Palatability of soybean curd

The mean palatability scores for the plain soybean curd and for the soybean curd salad mixture are given in Table 2. A desirable soybean curd is white or very lightly colored, tender, and bland. Since a rating of 4 for an individual factor corresponds to good, it is apparent that the judges considered the plain curds acceptable and thought that adding chopped onion, salt, and salad oil improved their palatability.

The mean total palatability scores ranged from 16.3 to 16.8 (out of a possible 20) for the plain curds made from the four varieties of beans, while the scores for the salad mixtures ranged from 17.3 to 18.1. Differences among varieties were not significant, although the mean scores for the texture of the curds from Mandarin soybeans were lower than those for the other curds. The texture of Mandarin curds was described by the judges as crumbly, watery, or mealy.

Among the four varieties of dry soybeans used in this study, the sample of Mandarin beans had the best appearance. The beans were even in size and light yellow in color. The lots of Harosoy and Jogun beans were similar, with a few brown or green beans scattered among the predominantly light yellow ones, while the Kim soybeans were green with black hilums. The curds prepared from Kim soybeans did have a lower mean color score than those made from the other beans, but the differences were not statistically significant.

Special recipes developed

Soybean curd meat balls, fried soybean curd in mushroom sauce, soybean curd and beef stew, soybean curd appetizer, soybean curd sandwich, scrambled eggs with soybean curd, soybean curd and tomato soup, and soybean curd with pea soup were tested and considered very palatable by the majority of judges. These recipes could be used to add variety to the American diet.

COXIELLOSIS (Q FEVER)

in Livestock and Man

D. H. FERRIS

JUST 25 YEARS AGO, coxiellosis, or Q fever, as it is more widely known, was an obscure medical curiosity. Now it has become a disease of grave importance.

It affects many species of animals and can be transmitted from them to man. In the Midwest, dairy cattle have been found to be the chief source of infection. Several states have therefore recently revised their regulations concerning raw milk and pasteurization.

Caused by a rickettsia

The causal organism is *Coxiella burnetii,* a rickettsia similar to the ones causing typhus and Rocky Mountain spotted fever. It is smaller than the other rickettsiae — so small that if 100,000 individual organisms were laid side by side, they would extend only an inch. *C. burnetii* is also more resistant to heat, drying, sunlight, and freezing than are the other rickettsiae.

Not only dairy cattle, but also beef cattle, goats, sheep, and many wild animals are important hosts. So far *C. burnetii* has been isolated from over 50 different species of vertebrates and as many species of arthropods. Human epidemics have been traced to rabbits in North Africa.

The organism may be shed in urine, feces, or milk, but birth fluids and placentas are probably more important sources of infection.

The spread of Q fever

The disease was first reported in 1937 among slaughterhouse workers in Australia. At almost the same time the organism was isolated from ticks in Montana. Since then, Q fever has been found on every continent.

The first human case of Q fever in the United States was reported in 1941. During World War II, many of our troops contracted the disease in southern Europe. Since the war, several epidemics, as well as increasing numbers of isolated cases, have been noted.

As shown on the map, Illinois is one of four states where human epidemics have been reported. Blood tests have disclosed livestock infections in nearly every state. In California and other western states sheep are frequently the reservoir for the organism. Positive blood tests of beef cattle have been made; however, dairy cattle are now considered a more important source of infection because they shed the organisms over longer periods of time. Isolations from ticks have been made in at least seven states, and recently isolations from rodents have been made in the west.

Large scale outbreaks have usually been traced to an aerosol of *C. burnetii* organisms, often in dust. Suburbanites living downwind from a dairy, people along the routes of a herd movement, people in towns near large sheep ranches, young people in livestock show rings, and processors of dusty straw, feathers, or hair have been among the victims of Q fever in the United States.

Obviously, people in certain occupations are more prone to infection than others. These include veterinarians, livestock handlers, and workers in laundries and slaughterhouses.

Effects on man

Man has a wide variety of responses to exposure. Some individuals have not been affected when exposed to heavy concentrations of extremely virulent organisms. Others, however, particularly older persons, have died. Fatal cases of endocarditis, resulting from chronic Q fever infections, have been reported from England.

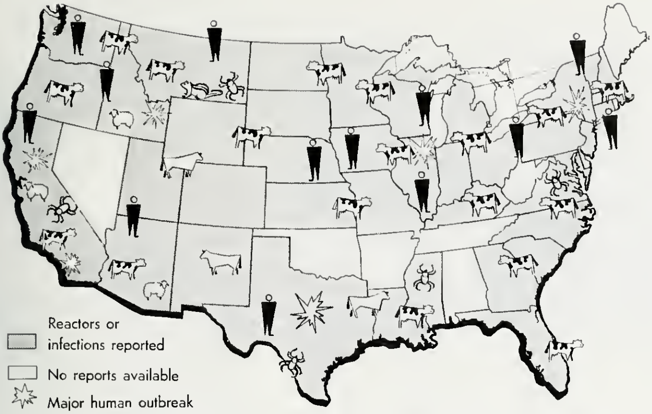
The usual incubation period is from 2 weeks to a month, depending upon the size of the infecting dose. The disease may strike suddenly, with no warning, or it may begin with a day or more of weakness and general lassitude. Chills, muscular aches and pains, frontal headache, and chest pain are early signs and symptoms. A fever of 103° to 105° F. usually develops during the first few days. In about half the cases, deep breathing causes a cough or pain by the fifth or sixth day. No rash is present as in other rickettsial infections.

Coxiellosis cannot be distinguished by its signs and symptoms from numerous other diseases. An epidemiologic team in Chicago, using laboratory tests after an outbreak in 1946, found that 33 cases had occurred in one slaughterhouse. Of these, 10 cases had been so mild that they were not reported to a physician. The other 23 cases had been reported but had not been diagnosed as Q fever.

A cooperative study

In 1957, the Illinois Agricultural Experiment Station and the College of Veterinary Medicine initiated a research project to investigate the potential threat of Q fever to agriculture and human health.

Because of the scope of the project, it has been a cooperative endeavor, requiring the assistance of many organizations. Dr. Lauri Luoto, Chief Veterinarian of the Rocky Mountain Laboratory of the U. S. Public Health Service, supplied reagents for a new and rapid blood test, permitting a continuous statewide survey of cattle, sheep, and other domestic animals. The State Department of Conservation and the State Natural History Survey have



Incidence of coxiellosis, 1937-1961. The disease was also found in Alaska and Hawaii. Pictures indicate the major hosts in each area.

helped to obtain data on possible wild animal reservoirs.

The University Health Service undertook a survey of human sera, largely from urban centers; the State Department of Public Health in cooperation with the College of Veterinary Medicine worked out a plan for the testing of human and livestock sera; Dr. Felix Tornabene, Public Health Officer of Will county, started an intensive investigation of an important sector of the Chicago milkshed; and the College of Veterinary Medicine initiated basic research on the activation of disease by *C. burnetii.*

Studies of the human aspects of the problem are being coordinated through the Center for Zoonoses Research, which was created by the University in 1960. Zoonoses are diseases that can be transmitted from animals to man. At present, the center in Urbana is the only one in the United States that is entirely devoted to research on these diseases.

Safety precautions

A secure isolation building, the Zoonoses Laboratory, is now being constructed for research on Q fever and other diseases. In the meanwhile, research is being done in a temporary laboratory on the Veterinary Medicine Research Farm.

Precautions have been taken for the safety of laboratory personnel and of the community. Animals used in the research are housed in secure cages, called Horsfal-Bauer units, which are attached to a special filter that removes small particles, even viruses, from the air. Laboratory operations are done under a hood. Personnel wear masks while in the units, and take other safety measures.

Results of surveys

In the first large-scale survey, 8,500 dairy animals in 887 different herds were tested. The herds were in 78 counties. Infection was found in 16 percent of the herds and 7 percent of the individual animals.

Infections were concentrated in the major milksheds, primarily the northern and west-central counties. Some counties seemed free of infection. In Champaign county, only one reactor was found among hundreds of animals tested.

This one reactor had been brought in from a county with a high incidence. Recently, goats positive to Q fever were also introduced from another county. Although such movements of infected animals have started new foci in the past, animals transported into the state do not seem to be a major source of infection. In one county, over 60 percent of the herds were infected, but few dairy cattle had been brought into that part of the state during the previous 10 years.

The movement of swine is not considered a factor in spreading the disease, because they are not regarded as carriers and they also seem quite resistant to the organism. Only 2.4 percent of 541 herds and 0.3 percent of 4,733 individual sera were found positive. Reactors had probably been infected from cattle.

Since sheep are a more likely source of infection, nearly 1,000 sheep were tested. Only two were positive, however, and both were from Illinois stock.

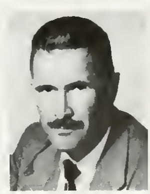
Deer, foxes, and raccoons have been found to be positive reactors. Efforts to ascertain the extent of a possible reservoir in Illinois wildlife are not yet complete.

Evidence from the sentinel herds throughout the state is that Q fever infection is not a static situation. Sera have been collected from these herds for several years and have been deep-frozen so that they could be tested as time would permit. Tests for all years are not finished, but so far most herds show fluctuations in incidence of infection, indicating that infection probably goes in cycles. Animals also showed evidence of reinfection.

Unanswered questions

Q fever was so named because its first investigator considered it a query or question. The name is still appropriate, for there are more questions than answers about coxiellosis. With the new Center for Zoonoses, it will be possible to open up new lines of attack upon this important disease of livestock and man.

D. H. Ferris, Associate Professor of Veterinary Pathology and Hygiene, has been at Illinois since 1957. He received his Ph.D. degree from the University of Wisconsin.



CHRISTMAS–TREE FARMING
Can Be a Profitable Enterprise

HOWARD W. FOX

UNTIL RECENTLY almost all Christmas trees used in Illinois were shipped in from the forests of the western United States and Canada. This situation is changing rapidly, however, with the new concept of Christmas-tree farming. Now Illinois produces a substantial percentage of its own Christmas trees.

Table 1. — Time Needed for Shearing 100 Trees of Different Species

Year of planting and species	Age when planted[a]	Growing seasons before final harvest	Time (min. per 100 trees)[b]
1952			
Red pine	2-2	0	32
White pine . . .	2-2 & 3-0	0	24
Scotch pine . . .	1-0	0	31
1953			
Red pine	2-2	1	80
White pine . . .	2-2	1	60
Jack pine	3-0	0	42
Scotch pine . . .	1-1	1	81
1954			
Red pine	2-2	2	55
White pine . . .	2-2	2	43
Jack pine	2-0	1	91
Scotch pine . . .	2-1	2	60
1955			
Red pine	3-0	3	22
White pine . . .	3-0	3	15
Jack pine	2-0	2	40
Scotch pine . . .	2-2	3	42
1956			
Red pine	2-2	4	20
White pine . . .	2-2	4	13
Jack pine	2-0	3	25
Scotch pine . . .	2-2	4	22
1957			
Red pine	2-1	5	7
White pine . . .	3-0	5	7
Jack pine	2-0	4	24
Scotch pine . . .	2-0	5	14

TOTAL SHEARING TIME FOR 6 YEARS[c]
(minutes per 100 trees)

Red pine	White pine	Jack pine	Scotch pine
216	162	222	250

[a] First digit is number of years in seedbed; second digit is number of years in transplant bed.
[b] Includes time moving from tree to tree.
[c] Jack pine is harvested in 7 years instead of 8, and is therefore sheared for only 5 years.

Some growers have developed Christmas-tree farming into a sound business enterprise, but most growers are still in the beginning stage. Many do not realize the labor and costs involved or the profit that can be expected. Knowing these facts is becoming more essential as competition becomes greater.

Cost records have been kept for 10 years on a pine Christmas-tree rotation area on Sinnissippi Forest in Ogle county, Illinois. The area consists of 13.05 acres of sandy loam soils which were farmed at one time, then abandoned to pasture. Being drouthy, the sandy loam did not produce good pasture, but without pasturing, it produced a heavy cover of bluegrass sod. This is the cover in which the plantations were established.

The 13.05-acre block was divided into eight areas of 1.63 acres each. Starting in 1950, one area was planted each year until all areas had been planted. The first area was clear-cut after the eighth growing season, and was replanted the following spring. The same procedure is being followed on the other areas. This report is based on a complete cycle on each c the first three areas.

Table 2. — Harvesting Time Study

	Minutes per 100 trees			
	White pine	Red pine	Jack pine	Scotch pine[a]
Cutting	16	24	29	15
Dragging	17	29	30	10
Loading[b]	40	53	40[c]	28
Hauling[d]	41	81	41[c]	29
Unloading and grading	93	112	93[c]	59[e]
Minutes per 100 trees	207	299	233	82

[a] Many were only tops because of deer damage.
[b] Includes cleaning out old needles and grass when needed.
[c] No actual record was kept, but experience indicates that Jack pine is similar to white pine.
[d] About 6.7 miles per round trip (22 minutes travel time).
[e] No record was kept, but the relation between "loading" and "unloading and grading" was considered to be the same as for red pine.

Shearing

Annual shaping, or shearing, is esser tial to produce dense, uniform tree It is done in the spring with hedg shears (Fig. 3). The time needed t shear different species of different ag was studied in 1959, using 100 tre for each combination of age an species (Table 1).

The first shearing is done 3 yea after planting — 5 years before fin harvest. Double or multiple leade are reduced to one, and extra lor leaders are cut back. Many trees a not touched, although each must be i spected. Even the following year, few trees at Sinnissippi do not nee shearing. Most, however, require cu back of the leader and side branch where the tree appears out of balanc

Trees to be harvested in 1, 2, or years usually require complete shearir — except for those that are definite not salable. About half the trees r quire shearing in the spring of tl year they are to be sold. This is t shorten the leader and laterals on fas growing trees which would appe

Table 3. — Average per Acre Expens and Income, Using 4- by 5-Foot Spac- ing or 2,178 Trees per Acre

Species of pine	Total costs	Gross income	Eight-year net profit	Net prof per yea
White . .	$389.90	$2,638.38	$2,248.48	$281.(
Red	500.61	2,912.25	2,411.64	301.4
Scotch . .	391.74	2,598.58[a]	2,206.84[a]	275.8
Jack	424.79	1,592.56	1,167.77[b]	145.9
Aver. . . .	422.50	2,480.24	2,057.74	257.2

[a] This average does not include 1959, because was not representative.
[b] Jack pine is normally harvested after 7 yea However, under the planting program at Sinnissip Forest, the land is not used the eighth year, so r profit was figured on an 8-year cycle.

he four species studied were (left to right) hite pine, jack pine, red pine, and Scotch ine. (Fig. 1)

rees were planted with a Michigan refor- tator pulled by a D2 caterpillar. (Fig. 2)

The author shears red pines. This operation is necessary to produce high-quality trees. (Fig. 3)

A McCulloch brush cutter proved safe for harvesting. It also saved labor because the operator didn't have to kneel in the snow or bend his back. (Fig. 4)

ıgged. If this isn't done, the benefits ' previous shearing will be lost.

arvesting operations

The time needed for harvesting op- ations is shown in Table 2. The :otch pine study was not considered pical because about 75 percent of the ees had been so badly damaged by :er that they had to be cut 2 to 3 et above the ground. Judging from ıst experience, it would normally take out as long to harvest Scotch pine as d pine.

Cutting. Jack pines were hand-cut th a curved pruning saw. All other ecies were cut with a McCulloch ush cutter (Fig. 4).

Dragging. The time needed to drag :es to the loading road depends, of urse, on how far one must go into : plantation to get them. (In this ıdy, Scotch pines were in the first, :ond, and third rows from the road; ite pine, fourth, fifth. and sixth; red ıe, seventh; jack pine, eighth and ıth.)

Loading and hauling. In loading, : man clears grass and dead needles from the tree and hands it to another man on the truck, who loads it. A straight truck with a 7½-foot by 12½-foot bed and 38-inch side racks is used. The number of trees that can be packed onto the truck varies with temperature, species, and mileage. When temperatures are below 20° F., trees cannot be packed tightly because any pressure on the branchlets may break them. Trees are not packed as tightly for short hauls as for longer hauls, mainly because the trees arrive in better shape when not compressed by heavy loads.

Costs and returns

Table 3 is a summary of all investments and income that can be expected on an acre of trees with 4- by 5-foot spacings. Figures are based on detailed records kept at Sinnissippi Forest for an 8-year cycle.

All expenses and income were based on 100 salable trees. In this study, an average of 138 trees were planted to produce 100 salable trees. A salable tree is considered to be any tree in the standard (U. S. No. 2), select (U. S. No. 1), and premium (U. S. Premium) grades.

Investments were compounded at 4 percent interest annually from the time of investment to the time of harvest. Labor was figured at $1.25 an hour. Average overhead and depreciation costs charged to 100 trees planted were $1.48. Real estate taxes were included, but no costs for the use of the land.

Shearing costs are based on the data in Table 1 but are for the total number of trees sheared to produce the 100 salable trees. A few trees that one shears trying to produce a salable tree, never make the grade.

Labor costs for harvesting were calculated from the time study summarized in Table 2. If a wholesaler's truck is loaded at the plantation, or if trees are retailed right on the farm, the costs involved in hauling to a central location and unloading are eliminated.

Expenses in Table 3 do not include any risk for fire, theft, or insect damage. No mowing or cultivating was done. In a continuous operation, one would expect a fire loss and some insect-control work. Mowing will probably come into the operations in the next few years. These things can add up to higher expenses, while greater competition will likely reduce future prices. Even so, a grower can probably expect a gratifying profit for many years if he handles his operations in a businesslike manner and does all he can to produce a superior product.

Howard W. Fox, Assistant Professor of Forestry, is Resident Forester of Sinnissippi Forest near Oregon, Illinois. This 2,500-acre research area was established by the late Frank O. Lowden in cooperation with the Department of Forestry. The forest is now owned by Dr. and Mrs. C. Phillip Miller and Mrs. Albert F. Madlener, Jr.

Breeding New PEAR VARIETIES Resistant to FIRE BLIGHT

H. C. BARRETT

It is now almost impossible to grow high-quality pear varieties, such as Bartlett and Doyenne du Comice, on a commercial basis in Illinois. The reason is fire blight — the single most important disease of pears in this state.

The disease is widespread in North America and in several other countries, but it is most devastating in the warm, humid regions of the eastern half of the United States and southern Canada.

History in Illinois

We don't know for certain when fire blight first appeared in Illinois, but all records point to its early residence in the state. Perhaps it followed the early settlers westward as they planted orchards of pears and other pome fruits, or perhaps it had been here from the beginning, living on the native hawthorns and Juneberries (*Crataegus* and *Amelanchier* species).

It might be said with some justification that fire blight and Illinois have shown a special "affinity" for one another because of certain events that have enjoined their history.

When the pioneer horticulturists of Illinois planted pear orchards, largely of seedling stock, they unknowingly created a vast experimental field where, by the process of natural selection, pear seedlings resistant to fire blight survived the multitudes that were stricken down and killed by the disease. At present the most promising source of fire blight-resistant pears lies in certain chance seedlings that originated in central Illinois.

From some of these seedlings has been developed the variety Old Home, which is resistant not only to fire blight but also to "pear decline," a malady that has destroyed thousands of pear trees on the west coast and threatens the entire industry. Old Home now forms the body stock for pears grown on the Pacific Coast.

Another event of historical importance occurred in Illinois in 1878, when Dr. Thomas Jonathan Burrill proved that fire blight is caused by a bacterium. This discovery was a milestone in plant pathology. It was the first time that a bacterial organism was proved to be the cause of a plant disease.

Symptoms and effects

The bacterium (*Erwinia amylovorous*) that causes fire blight attacks all parts of the tree — roots, trunk, branches, leaves, flowers, and fruit. Most common of the noticeable symptoms are dead branches with dead, blackened leaves still attached. These give the tree a burned, blackened appearance — hence the name, "fire blight."

Blossoms and developing pear fruits also die, turn black, and remain attached to the fruit spur. Later the leaves on the spur may become infected and blackened. During severe epidemics the whole crown of the tree may appear black and dead. Young growing shoots are readily infected. The blight may move down the branches to the trunk and the roots. Very often the entire tree of a susceptible variety like Bartlett may be dead by the end of the growing season.

No good chemical control

Two antibiotics, streptomycin and terramycin, as well as some copper compounds, have helped somewhat to control fire blight infection in the blossoms. However, these sprays or dusts, especially the antibiotics, are very costly. And none of them control fire blight in other parts of the tree, where the disease is most serious and difficult to control.

In Illinois and most of the eastern United States, the pear blossoming season is short. Even under the best of conditions, the antibiotics or copper compounds can protect the trees against fire blight for only a few days during bloom. During the rest of the growing season the trees are unprotected and cannot be defended against fire blight by any known chemical sprays or dusts.

Search for resistant pears

Breeding pear varieties resistant to fire blight offers the greatest hope of ultimate success in controlling this disease. A large collection of pear material from both European and American sources has been tested at the Illinois Station. Many pear clones have been artificially inoculated with the disease organism to isolate types having a high resistance to fire blight. In addition, field observations under conditions very favorable to natural infection were made for several years.

Thus far, most of the desirable resistant pears have originated in central Illinois, a region where climate and soil are probably more favorable to fire blight than in any other area of the world.

Farmingdale, a seedling pear originated by the late Benjamin Buckman on his farm near Farmingdale in central Illinois, offers the best source of resistance thus far discovered. This is a large, handsome pear, and the tree is productive and

H. C. Barrett is Assistant Professor of Plant Breeding.

DO YOU KNOW OF ANY PEAR TREES in your area that have produced fruit without becoming infected with fire blight? If so, the author would appreciate your writing him at the Vegetable Crops Laboratory, University of Illinois, Urbana.

strong. However, the quality of the fruit is poor, so the variety has no commercial value.

Breeding methods

A number of other resistant pear clones besides Farmingdale have been utilized in the breeding work in order to have as broad a base of resistance as possible for selecting out resistant seedlings. Among the clones of Illinois origin that have been used are Illinois Bartlett, Illinois 38, Illinois 76, Lincoln, Old Home, and Sudduth, as well as several unnamed selections called to the author's attention by observing fruit growers and gardeners of the state. Clones from other parts of the world have also been used.

The resistant selections are crossed with high-quality, blight-susceptible commercial varieties in order to combine resistance with desirable commercial qualities. The resulting F_1 seedlings are artificially inoculated with the fire blight organism or are grown in the field under conditions highly favorable to blight infection. Susceptible seedlings are thus eliminated as rapidly as possible. Resistant F_1 selections that appear promising are crossed with other resistant F_1 selections of similar breeding or are back-crossed to other commercial high-quality varieties. The purpose is to further improve certain fruit qualities and maintain fire blight resistance in the succeeding F_2 generation. Thus, the various selected lines of descent will eventually bring together resistance from several sources as well as the most desirable qualities of the best commercial pear varieties.

The two fruits at upper left are Bartlett; at upper right, Max Red Bartlett, a red-fruited genetic mutation of Bartlett. Bottom two fruits are Farmingdale, one of the best sources of resistance to fire blight.

Each of these F_1 selections had Farmingdale as one parent, and Bartlett or Max Red Bartlett as the other parent.

Many seedlings produced

More than 10,000 seedlings from 160 controlled crosses have been planted in the orchard and nurseries at Urbana, where the most promising types are being selected. Over 30 selections that combine fire blight resistance with desirable fruit and tree characters will be observed further and tested more intensively. Several more years of evaluation will be necessary before any decision can be made as to their possible value to the fruit industry.

Breeding pears for high fire blight resistance and desirable fruit qualities is a challenging research problem, and as with most research problems, there is no quick or easy answer. Results to date have been encouraging, however, and it seems reasonable to expect that resistant, high-quality pears will be grown in Illinois before too many years.

New Tools for Community Betterment

J. B. CLAAR

THE NEED for economic growth and social development was never greater than it is today.

Some communities are growing rapidly and have the problem of assimilating large influxes of population. Fifteen counties in Illinois accounted for about 96 percent of the 1⅓-million increase in population between 1950 and 1960.

Most other Illinois counties are losing population and have the problems of increasing opportunities for their citizens and of maintaining local institutions.

Counties in both situations face community development problems. These problems are of such scope that most of them cannot be considered as rural or urban, but must be tackled on a broad, community-wide front.

Possible improvements

Although Illinois continues to be a great agricultural state, farming must be supplemented by off-farm employment in many areas if rural people are to enjoy economic opportunities and incomes in keeping with other segments of the population. Balanced economic growth is important to rural people.

Expanding employment is just one type of community development. Many Illinois counties have, through the years, carried on community betterment programs with assistance from the Cooperative Extension Service. These programs have resulted in better health and recreation facilities, improved roads, and other benefits.

The contributions of Extension workers to communities desiring improvements are several:

1. Creating awareness of problems and opportunities and encouraging people to solve their problems.

2. Helping communities to organize on a broad front.

3. Providing pertinent information and helping people gain access to other sources of help.

Rural areas development program

Now, with the rural areas development program of the U. S. Department of Agriculture, Extension workers have an excellent tool for continuing their educational role in community leadership. The program has several aspects which should make it effective:

1. It recognizes the need for organized community action.

2. It provides the framework for coordinated aid by federal, state, and other agencies.

3. U. S. Department of Agriculture agencies have specific assignments.

The Extension Service has the responsibility for organizational leadership. A state committee has been formed, with representatives from nearly 30 organizations. Dean Louis B. Howard of the College of Agriculture is chairman.

Meeting with this state committee is a technical committee, made up of U. S. Department of Agriculture workers not in Extension. It is chaired by the state director of the Farmers Home Administration.

It is anticipated that many Illinois communities will want to organize local committees for community improvement. The rural areas development program applies to both high and low income areas. The problems may be different, but the process needed to recognize and solve them is the same. Some may involve less than a county; others may transcend county lines.

A new tool for specified areas

The new Public Law 87-27, sometimes called the depressed areas bill, provides additional tools for nearly 25 counties in southern Illinois.

They have been selected because of chronic unemployment, on the basis of data from the Department of Labor. They may apply for approval of several types of projects:

1. Loans for industries and commercial projects.

2. Loans and grants for public facilities.

3. Technical assistance.

4. Occupational training.

5. Retaining subsistence payments.

The provisions of the law are administered by the U. S. Department of Commerce through the economic development body in each state. In Illinois this body is known as the Board of Economic Development.

A continuing program

Of course most Extension programs and most applied research of the Experiment Station are related to community improvement, either directly or indirectly. They help to develop leadership through enhancing the intellectual growth of people.

The growth of people through education is the ultimate aim of Extension work. The 4-H program, for example, helps young people develop into useful and responsible citizens. And certainly Extension programs that use local leadership have helped train community leaders.

Many of the programs that have improved farm production, marketing, and management have contributed greatly to rural communities.

Certainly these significant programs must be continued. At the same time, the increased interdependency of people calls for more emphasis on community-wide programs. The economic growth and social situation in a community determine the framework in which its residents conduct their business, earn their livings, and develop their potential for living full, fruitful lives.

J. B. Claar is Associate Director of the Extension Service.

TOO FEW STUDENTS FINISH COLLEGE

K. E. GARDNER

Two serious problems confront those of us who are involved in college instruction in agriculture: Too few of our farm youth attend colleges of agriculture. And of these, too few complete their course of study. The latter problem, which is not confined to agriculture alone, is the one that I should like to consider in the following paragraphs.

Some reasons for failure

These are some of the reasons why students fail academically in college or do not complete their full term of study.

Immaturity. Most boys are immature at 18 and some extremely so. The more mature G. I.'s who attended college right after World War II did well academically. We have found, in general, that if students with poor academic records drop out of college for one or two semesters and then return, they do much better in their studies. On the other hand, educators hesitate to recommend a period of work or military service prior to college attendance for fear that the student will "get the feel of the long green" and refuse to stop earning and start spending on a formal education.

Poor motivation. Many students are motivated more by parental concern than by their own drive. It is fine that parents want their children to become educated, but it is *essential* that the student also have this desire.

Motivation is strongest when the student knows what field of work he wants to enter. At the same time, students should realize that a college education offers more than professional or vocational training. Too many students immediately criticize a theoretical or cultural course because it does not provide a means of increasing personal income.

K. E. Gardner is Associate Dean of the College of Agriculture.

Poor preparation. Some students have attended schools with low requirements. Often high school English classes are so large that the teacher can't require and grade sufficient written work. Many students report that they never had to write a single theme in high school.

These students can usually depend on having difficulties, since a great deal of written work is required in college. In fact, poor preparation in rhetoric and grammar is probably one of the greatest stumbling blocks to college students.

Slow reading. A student who cannot read with speed and comprehension will always have difficulty in college work. Parents should encourage their children to read and then read some more.

Failure to work. Many things come easy for youth these days. Higher education is not one of them, at least not in a high-caliber institution. The lazy student just cannot survive — unless he is exceptionally brilliant.

Inadequate ability. Some students just do not have the capacity for academic work. This does not mean that they will not be successful in many occupations. It merely means that college is not for them.

Financial problems. Some students have to work too many hours to stay in college. The brilliant or the better-than-average student *can* do a considerable amount of work toward paying the cost of education. The average or below-average student, however, must curtail his work for pay, or he will find himself in scholastic difficulty.

Too many activities. Most students want to participate in the many extra-curricular activities on the campus. Under judicious control, these activities are very helpful in developing the social capacities of the student. When they are overdone, however, they detract from the academic effort. Excessive dating can also bring down the grade-point average.

Too much absence from campus. When spring comes, many a farm boy sniffs the breeze and decides that dad cannot operate the farm without his help every weekend. By going home Friday night and returning late Sunday, the student very neatly deducts 40 percent of his potential study time.

Miscellaneous causes. Sickness, love affairs, homesickness, fear of failure itself, conflict at home, and a myriad other problems beset certain students. Death, sickness, or accidents in the family may require a student to return home without completing work for his degree.

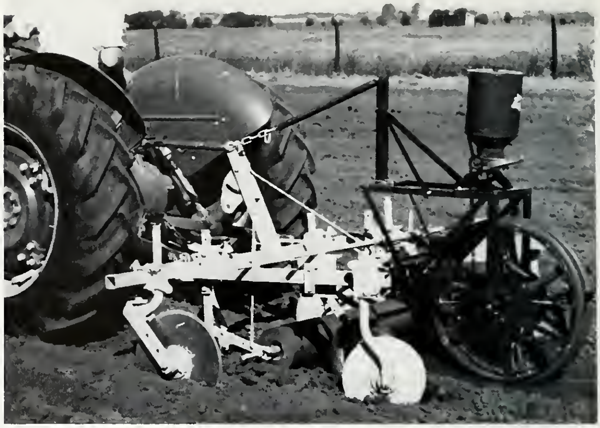
Help is available

In the College of Agriculture, each student has a faculty adviser to assist him with his problems. In addition, the Office of the Associate Dean consults daily with dozens of students. The University has a counseling bureau with psychological and other experts, and the Office of the Dean of Students also offers help. Numerous scholarships and loan funds are available to help students with their financial problems.

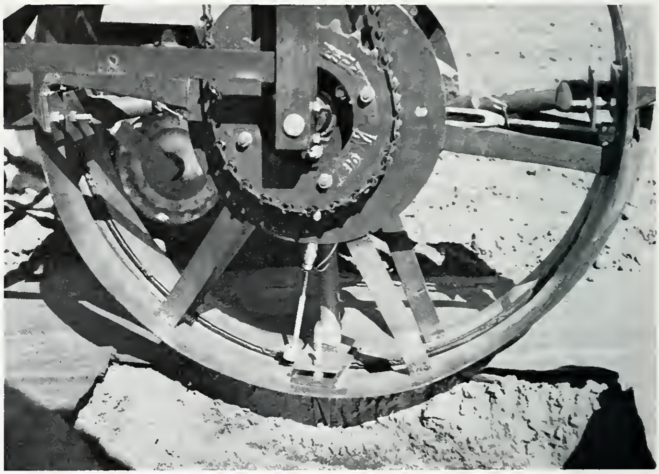
When further attendance in college appears unwise, then it is the job of the Associate Dean's office to encourage the young man or woman to assess his strong points and make optimum use of them. "All is not lost" when a student fails in his school work. Many successful people never attended college.

However, we do our best to encourage students to continue their education whenever it seems possible and wise. College *is* a remarkable opportunity for young people to make the most of their capacities and develop their sensitivity to American and world culture.

A VEGETABLE SEEDER That Plants Through Plastic and Paper Mulch



DONNELL HUNT



The seeder is attached to the mulch-laying machine. Four pointed valves on the rim of the wheel punch through the mulch and deposit the seed.

LATELY MANY VEGETABLE GROWERS have been using paper or plastic sheet coverings for some of their specialty crops (ILLINOIS RESEARCH, Winter, 1960). While this practice is quite expensive, it may be economically justified when the following benefits are obtained:

1. Retention of soil moisture and control of erosion.
2. Higher soil temperatures, resulting in rapid germination and earlier and faster plant growth.
3. Increased yields of healthier, cleaner fruits.
4. Excellent weed control.
5. Reduced insect damage (if treated papers are used).

It's difficult to place the plastic or paper mulch by hand. Both are purchased in large rolls 40 inches wide or wider. As the roll is unreeled, the edges must be immediately anchored with a soil cover to prevent whipping and tangling by the wind.

A mechanical mulch layer is necessary for a commercial grower. For the past 2 years the Departments of Horticulture and of Agricultural Engineering have cooperated in adapting a new, commercially available machine so that it can lay mulch under Illinois conditions. Changes in the furrow-making and edge-covering devices, plus a new method of unrolling the mulch, have produced a highly successful machine.

Now the Department of Agricultural Engineering has developed a vegetable planter that can be attached to the mulch-laying machine and can plant through the mulch. Such a machine was obviously needed, since paper or plastic mulch should be applied at seeding time for maximum benefit.

The seed is metered at the seed box and falls through tubes and a valve into the hub of the planter wheel. From there it is directed toward one of four exposed and sharp-pointed valves on the rim of the wheel. The valve punches through the mulch to deposit the seed below the mulch. Both variable depth and variable spacing adjustments are provided. The machine did a satisfactory job of planting squash, cucumber, and watermelon seed at both Urbana and the Dixon Springs Station last June.

Further work is planned to improve the present machine and to develop a transplanter which can work through a plastic or paper mulch.

Donnell Hunt is Associate Professor of Agricultural Engineering.

RESEARCH IN BRIEF

Loss of Fertilizer Nitrogen by Denitrification

A local farmer has reported that his corn crop showed nitrogen deficiency symptoms even though he had plowed down 100 pounds of nitrogen fertilizer per acre last fall. A few other similar reports have also been received. Does this mean that nitrogen has been lost? It probably does, and you may lose some also, if certain conditions exist.

When ammonium fertilizer is added to the soil, little or no nitrogen will be lost until it is converted to nitrate. In most Illinois soils, however, soil microorganisms soon convert ammonium fertilizer to nitrate during the spring, summer, and fall. Once in nitrate form, nitrogen can be lost from the soil, so that it is no longer available for plant growth. Thus, the crop may not use all of the nitrogen from ammonium or nitrate fertilizers.

At least one important pathway by which nitrate can be lost is through denitrification. In the process, soil microorganisms change nitrate to nitrogen gases which escape into the atmosphere.

These denitrifying organisms thrive in the soil if two conditions exist. The first condition is poor aeration, which may be caused by poor drainage of water-saturated soils. The second condition is a large source of energy food. Plowing under large quantities of oat straw or cornstalks provides much energy food for the organisms.

When some soils were near water saturation in laboratory studies, as much as 90 percent of the added nitrogen was lost in 10 days. This means that if you apply 100 pounds of nitrogen per acre in the fall or early spring and your soils are near water saturation for extended periods, most of the nitrogen may be lost into the air before crop growth begins.

If conditions that are conducive to denitrification exist in your soils, you may wish to apply your nitrogen fertilizer closer to the planting date of the crop. This will decrease the possibility of nitrogen loss and increase crop utilization. — *B. R. Sabey*

Research Shows Most Efficient Use of Liquid Urea Fertilizers

If liquid urea comes into contact with the leaf surfaces of plants, some nitrogen may be lost in the form of gaseous ammonia. This has been indicated by recent research with liquid urea fertilizers, conducted under laboratory conditions.

When rate of application is less than 50 pounds of nitrogen per acre, losses are small and of no practical significance. When application rates approach 150 pounds of nitrogen per acre, however, losses may be as high as 25 percent on some crops. For losses of this magnitude to occur, most of the urea solution has to come in contact with plant leaves, and remain in contact for several days.

Nitrogen losses varied with different crops. Losses were lowest for field rye and highest for an established bluegrass sod. Wheat and bromegrass showed greater losses than rye, but less than bluegrass.

No measurable nitrogen losses, as gaseous ammonia, occurred when the liquid urea fertilizer was applied directly to the soil surface. Therefore, when liquid fertilizers containing urea are applied, care should be taken to get as much as possible on the soil and as little as possible on the leaf surfaces of growing crops.

Urea applied to soil is subject to leaching, much like nitrates, until it hydrolyzes to ammonia. The rate of movement, or susceptibility to leaching, of urea is about the same as that for nitrates in most Illinois soils. Once the nitrogen in urea has hydrolyzed into ammonia, it becomes resistant to leaching as long as it remains in the ammonia form and is not oxidized into nitrate.

Under warm temperatures (75° F.), urea applied to Illinois soils hydrolyzes into ammonia in a matter of 2 to 4 days. Under cool temperatures (40° F. or less), the rate of hydrolysis is slow, but still measurable in most soils. Late fall applications of urea generally would be expected to hydrolyze into ammonia in less than 30 days. At this time of year the ammonia would not be quickly oxidized into nitrate. Thus, leaching losses would be minimized.

Spring applications of urea are satisfactory on all soils. When applied to pastures or small grains, the acre rate of urea nitrogen should be kept below 50 pounds to minimize gaseous ammonia losses from the surface of crop leaves. — *D. M. H. Simpson and S. W. Melsted*

Radioactive Acetate Used to Study Rates of Acetate Metabolism in Sheep

Ruminants get most of their energy for body functions from the volatile fatty acids — acetic, propionic, and butyric — which are produced in the rumen by microbial fermentation of the plant material eaten by the animal. In the Department of Animal Science we have been interested in the rates at which these acids are produced in the rumen and then metabolized in the body.

Since acetate is found in greatest concentration in the rumen and is considered to contribute more to the animal's energy supply than the other acids, we have begun by studying this acid, using fed sheep as our experimental animals. We have used radioactive acetate and techniques that involve measuring the dilution

of the labeled material by the acetate being produced in the body.

To study rates of acetate production in the rumen after feeding, we added acetate-1-C^{14} (radioactive acetate) directly to the rumen through a rumen fistula and measured the rate at which the radioactive acetate that we added was diluted by acetate freshly produced in the rumen. The values obtained are in agreement with those found at Maryland by the perfused rumen technique.

In the metabolism studies we infused highly radioactive acetate into a jugular vein or into a rumen vein for periods up to 14 hours long. At the same time we collected blood samples and also collected respired CO_2 with a tracheal catheter. After we stopped infusions, we obtained the disappearance rate (half time) of acetate in the blood by measuring the rate at which the radioactive acetate was diluted by fresh acetate coming into the bloodstream from the rumen.

Under these conditions the level of radioactivity of blood acetate reached a constant level almost immediately and that of respired CO_2 at 4 hours after commencing infusion. The following average values were calculated: acetate pool size (amount of acetate in the body at any one instant), 0.5 to 0.8 gram; turnover rate (rate at which the body uses acetate), 0.24 to 0.36 gram per minute; turnover time (time taken to use an amount equal to the pool size), 2 to 4 minutes; acetate space (fluid in which the acetate is dissolved), 30 percent of body weight.

With bodily processes in equilibrium, 30 percent of the infused acetate appears as CO_2, and 40 percent of the respired CO_2 (and therefore about 40 percent of total energy used by the animal) comes from the metabolism of body acetate.

Similar experiments have been conducted both here and elsewhere using fasted animals. We used fed animals, however, because it seems to us that the important time to measure acetate metabolism is when normal amounts of acetate are coming into the body from the rumen. — *B. Connor Johnson and John R. Sabine*

Nitrate Content of Corn Increased by Thick Planting and Fertilization

Much research has been conducted to improve corn yields. Both bushels of corn per acre and tons of silage are increased when the latest recommended hybrids are planted at the proper time and at recommended seeding rates. This is especially true if enough fertilizers — especially nitrogen — are applied, and if rainfall and other weather conditions are ideal.

Not nearly enough attention has been given to the feed value of the resulting crop. Recent occurrences of nitrate toxicity are evidence that we need to investigate the effect of cultural practices on the value of crops grown. Even more important, it now appears that excess nitrate in cattle rations interferes with normal utilization of carotene, the precursor of vitamin A.

One factor that increases the nitrate content of the growing corn plant is excessive self-shading, due to extremely thick stands. The shading reduces the activity of nitrate reductase, the plant enzyme that acts on the nitrogen taken up by the roots and converts it into plant protein. It is also known that large amounts of available nitrogen in the soil, or fertilization rate, can increase the nitrate content of the corn plant.

Research was therefore planned in the Beef Division to study the effects of planting rate and nitrogen fertilization upon the nitrate content of the growing plant and of the silage made from the resulting crop.

Four comparable fields were fertilized and seeded as follows: (1) no fertilizer, 32,000 seeds per acre; (2) no fertilizer, 16,000 seeds per acre; (3) 10 tons manure plus 300 pounds ammonium nitrate, 32,000 seeds per acre; (4) fertilized like "3," 16,000 seeds per acre.

Samples were taken from each plot for nitrate analysis at weekly intervals from mid-July until frost, and separated into leaf, stalk, husks, cob, and grain. One row was left in each plot for determination of grain yield. One silo was filled from each plot and the resulting silage fed to beef calves to determine the feeding value of the corn. Both nitrate and carotene content were determined on comparable fresh and ensiled samples of the entire corn plant.

The application of fertilizer significantly increased the nitrate content of entire corn plant forage and silage. When fertilizer was used, thick-planted corn contained significantly more nitrate than thin-planted corn. The vitamin A status of steers was adversely affected by high nitrate content in the silage, even though carotene content was highest when fertilizer was used. — *A. L. Neumann and G. S. Smith*

Manufacture of Commercial Feeds in Illinois

Illinois ranks first among the states in the production and distribution of prepared animal feeds. Plants manufacturing prepared feeds are located throughout the state, so animal producers have close access to the supply. During 1959, a registered, commercially mixed feed was prepared at 399 different locations, with none of the nine crop-reporting districts having fewer than 31 plants. The concentration of plants was greatest in the northeastern and west-southwestern districts, each with 62 plants.

About 40 percent of the active plants in 1959 registered a prepared feed for only one class of animals, and another 36 percent limited their output to feeds for either two or three classes of animals. In contrast, nearly 9 percent of the firms prepared a feed for seven or more classes of animals, including pets and fur-bearing animals.

Fewer plants produced registered feeds in 1959 than in 1949. At one time or another between 1949 and 1959, a commercially mixed feed

was made at nearly 800 locations. About half of these had discontinued by 1959. The other half was about equally divided between those which began registration after 1949 and those which registered feeds continuously throughout the entire period.

More plants began feed registration between 1955 and 1959 than between 1950 and 1954. The number of plants which were active in 1949 and then discontinued exceeded the number which began after 1949 and then discontinued.

These shifts in locations of commercial feed plants reflect changes in the production of livestock and farm-produced feed within different areas of the state, changes in transportation costs, and changes in methods of feeding, as well as deaths and changes in competitive strength among commercial mill operators.

In addition to commercially mixed feeds, large amounts of feed in Illinois are custom-milled and mixed at local points, are prepared on farms with mobile custom mills, or are processed by farmers with their own equipment. — *R. J. Mutti*

Thanks to Our Readers

Last summer we sent a questionnaire to 2,000 of you, asking your opinions about Illinois Research. The names were chosen at random from our mailing list. More than 1,000 returned their questionnaires — for which we thank you. We also thank you for your encouraging comments and for your constructive criticisms.

Some of you used the back of your questionnaires to request information. If we've been slow about replying, it's because we first wanted to tabulate the results of the questionnaire. But now your queries have been referred to the proper departments for answering.

Most of you seem satisfied with the format of Illinois Research and the type of information it contains. So we're not making any drastic changes, although we will keep trying to do a better job, using your comments and opinions as a guide.

Increasing Acidity of Tomato Fruits for Processing

Tomato fruits must have an adequate level of acidity for at least two reasons. Organic acids, especially citric acid, help give tomatoes their characteristic flavor. In addition, acids are necessary to keep canned tomatoes from spoiling. Certain bacterial spores that are not killed in the heating process later germinate and contaminate processed tomatoes that are low in acidity.

In recent years processors have experienced large money losses either through spoilage of canned products or through capital outlay for reconstituting tomato products to reach minimum acidity standards. Lots with low acidity may be improved by mixing them with concentrated tomato products. However, acids cannot be added to the tomatoes because the Pure Food and Drug Administration considers this an adulteration.

The full importance of higher acidity is now being recognized, especially since mechanical harvesting of tomatoes for processing is nearly a reality. To obtain high yields from a tomato plant in one harvest, many fruits will have to be left on the vine longer than is now done with hand harvest. Because acidity content markedly decreases with prolonged ripening, it is essential that the potential acid content be high.

Since most cultivated varieties of tomatoes contain about the same amount of acids, an extensive search for new sources of higher acidity was begun by the Department of Horticulture. Several selections were made in 1953 from wild tomato species having small, red, "cherry" type fruits that contained over twice as much acid as cultivated varieties. Crosses were made to standard varieties, and selections containing high acidity were crossed back to standard varieties to improve fruit size and other horticultural characteristics. We now have breeding lines with fruits that are as large as those of most varieties and that contain about 50 percent more acids. Research is now in process to determine the inheritance of high acidity and to improve the methods of selecting and breeding for this important character. — *A. E. Thompson*

Why Flannel Skirts Lose Their Shape

Flannel skirts that had been discarded by their owners were studied to find out how badly the fabric had been worn. None of the fabrics were seriously damaged. However, the fabric in the seat area of most of the skirts had stretched — which is why they had been discarded.

In many skirts the stretching occurred in both the warp and filling directions, while in others it occurred in one direction only. This seemed to depend on the design and closeness of fit of the skirts.

Stretching seemed to be greatest for fabrics that had lost the most in compressibility. It was therefore felt that the loss of shape was caused by the nap rubbing off from the yarns. This would reduce the diameter of the yarns, and it would take less length of the interlacing yarn to go around them. All the original "crimp" put into the yarns when the fabric was woven would no longer be needed and could be stretched out under stress. Crimp losses in the seat areas ranged from 2 to 4 percent (a 2- to 3-percent change in dimensions is usually considered enough to spoil the fit).

Two skirts in the study had seat linings. These seemed to prevent stretching in the filling (crosswise) direction but not in the warp direction. — *Ruth Legg Galbraith and Jane Snowden Craig*

FARM BUSINESS TRENDS

Is it time for some farmers to change their cattle-feeding programs? A study of recent seasonal swings in prices of fat cattle suggests that it is.

Before 1958, prices for fat cattle generally averaged higher in the late summer and fall than in the earlier months of the year. Many farmers established cattle-feeding programs to take advantage of these higher prices.

In each of the last four years, however, prices for fat cattle have averaged highest in the first half of the year. The many farmers who sold their cattle in the later months often received unprofitably low prices.

There formerly were good reasons why prices for fat cattle were higher in later summer and fall. There now seem to be some good reasons for expecting higher prices in the winter and spring.

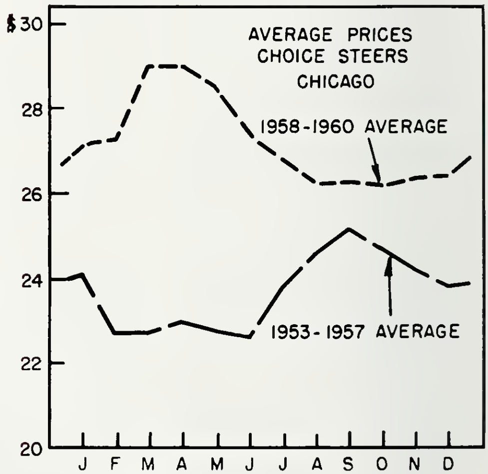
In the earlier years ranchers kept their cattle until they were at least two, and often three years old. Corn belt farmers bought cattle in the fall and fed them grain for three to six months. Large numbers were fat and ready for market in the winter and spring. Heavy receipts tended to depress prices of the fattened cattle.

In recent years ranchers have sold increasing numbers of cattle as calves and light yearlings. Farmers buy them in the fall and carry them for several months on roughage to get low-cost gains. The grain-feeding period begins in the spring or summer. This makes large numbers of fat cattle for the late-summer and fall markets.

One other development has helped to change the seasonal pattern for prices of fat cattle. This is the leveling-out of monthly pork supplies.

Hog marketings formerly were light during the summer and early fall. This diverted consumer demand to beef. In recent years farmers have spread marketings of hogs more uniformly through the year. Supplies of pork are more abundant during the summer and early fall, providing relatively more competition for beef in these seasons than formerly.

We have, of course, no good reasons for expecting that prices of fat cattle will reach their highest levels in the first half of every year. But the price advantage of feeding programs leading to late-summer and fall marketings is past. Farmers now have more freedom to adopt year-round feeding programs and other cost-reducing, profit-making practices. — *L. H. Simerl, Professor of Agricultural Economics*



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To:

Winter, 1962

ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

IN THIS ISSUE

The University's first building. This year we celebrate the hundredth anniversary of the Land-Grant Act (page 3).

Volume 4, Number 1 UNIVERSITY OF ILLINOIS COLLEGE OF AGRICULTURE URBANA, ILLINOIS

ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

CONTENTS

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RESEARCH IN THE DEPARTMENT OF HORTICULTURE today bears little resemblance to the research of almost a century ago, when the Land-Grant colleges were established. Early research consisted of simple variety trials and similar investigations, but answers that can be obtained from such investigations have been found. Today's horticulturist seeks an understanding of the basic laws of nature and knowledge of the elements of the soil and air in which plants thrive. Through 43 organized research projects, scientists in the department use the basic tools of genetics, physiology, and biochemistry to provide the consumer with economical, high-quality horticultural products.

Production research in horticulture has been notably successful. For example, Illinois tomato production has increased from 6 to 20 tons an acre during the last 15 years, and many other horticultural crops, such as apples and peaches, have increased similarly. This increased efficiency, along with our quality-control and consumer-acceptance studies, are important to the consumer, who, in Illinois alone, spends over 700 million dollars a year on fruits and vegetables. Other typical research programs include a genetic basis for apple scab resistance, relation of enzymes to fruit softening in tomatoes, and CO_2 control in greenhouses. We also contribute to the esthetic side of life through our work with flowers, nursery crops, turf, and horticulture therapy for the aged.

The complex data resulting from this research are interpreted for the layman by Extension workers, and are presented to the college student through 34 courses, ranging from beginning courses to advanced courses for a Ph.D. degree. — *C. J. Birkeland, Head of the Department*

Dr. Birkeland has been in his present position since 1949. He received his Ph.D. degree at the University of Illinois in 1947 and his previous education at Kansas State University, Michigan State University, and North Dakota State University.

Sixty-eight colleges and universities celebrate

THE LAND-GRANT CENTENNIAL

ONE HUNDRED YEARS AGO, Abraham Lincoln turned from the cares of the Civil War to sign the act which made possible the University of Illinois and 67 other colleges and universities throughout the United States.

This was the Morrill Land-Grant Act, named after Representative Justin Morrill of Vermont, who introduced and fought for the bill in Congress. It granted public lands to every state for the endowment of universities within the reach of anyone who had the ability and desire to learn. Instruction in agriculture and the "mechanic arts" was to be offered, without excluding the traditional classical studies.

Jonathan Baldwin Turner

Much of the credit for the Land-Grant Act must go to Jonathan Baldwin Turner of Illinois. A native of Massachusetts, he came to Jacksonville in 1833 to teach at Illinois College.

He was soon to become an outspoken critic of the traditional colleges. Their curricula were copied from European models, emphasizing Greek, Latin, and other classical studies, and almost ignoring science and the development of new knowledge. True, they did an excellent job of educating ministers, lawyers, and other professional people. But, asked Turner, shouldn't people in farming, commerce, and industry also have an advanced education suited to their needs?

Others besides Turner were asking this question and advocating a new type of college that would fit a changing society. In fact, a few colleges were already combining practical training with formal education. However, it was Turner who fused various plans and ideas into one definite, forceful, nationwide plan.

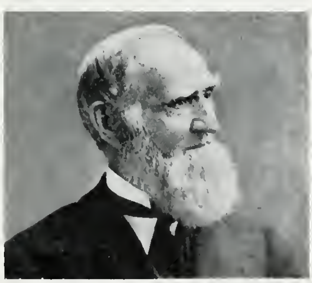
The plan goes to Congress

Turner's speeches and articles won many enthusiastic supporters. By 1852, some of them petitioned the Illinois Legislature to request Congress "for an appropriation of public lands for each State in the Union for the appropriate endowment of universities for the liberal education of the industrial classes."

In 1853, the Legislature did request Illinois representatives and senators to work for such an appropriation. Despite widespread national support for the plan, however, there was strong opposition. It wasn't until 1859 that Morrill's first bill passed both houses of Congress, and then it was vetoed by President Buchanan. A second bill was passed in 1862, and President Lincoln signed it on July 2 of that year.

Early years of the University

Under the Land-Grant Act, Illinois received 480,000 acres of land to found a university. The new school (known until 1885 as the "Illinois Industrial University") opened its doors in 1868, with 50 students, three teachers, and one head farmer. Classrooms, dormitories, dining hall, and chapel were all housed in one unfinished building.



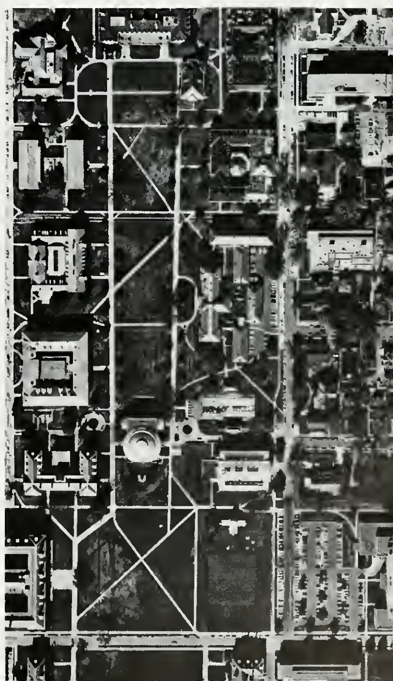
Colleges for the working people were the dream of Jonathan Baldwin Turner.

Almost at once, the new University set out to serve the state through extension and research, as well as through college teaching. Extension activities at first took the form of institutes — or courses of public lectures and discussions — the first one held at the University 10 months after it opened. Later ones were scheduled throughout the state.

Research also got underway the first year, with an experiment on raising vegetables. But the land was in poor shape to start with, early spring rains rotted the seed, and cattle trampled the plants that did come up.

More serious troubles plagued the University during its early years. Some farmers and others were indig-

The 535-acre campus at Urbana-Champaign now has over 100 major buildings.



nant that the traditional classical subjects, as well as the new practical ones, were included in the curriculum. However, the first regent, John Milton Gregory, had wisely insisted that all branches of knowledge were necessary to develop a great university, and he was finally able to mollify most of his critics.

There were financial difficulties too. Income from the sale of the public lands did not meet the University's needs — particularly after the panic of 1873 — and legislative appropriations were slim.

Enrolments remained low for a number of years, with agriculture lagging far behind the other departments. One reason for agriculture's poor showing was the lack of jobs for agricultural graduates. Another was that as yet there had not been enough research to develop a real science of agriculture.

Through these and other difficulties, however, staff and students retained their optimism and enthusiasm, and finally the tide began to turn.

Growing acceptance

In 1887, the Hatch Act granted every state $15,000 a year for agricultural research, and the University immediately made plans for a true experiment station. By the end of the year, more than 60 experiments were underway. Three years later the Morrill Supplementary Act made even more money available.

Through its experimental work, extension activities, and advertising, the University was gradually growing in public favor. And its enrolment was growing too, although it was still only about 800 when Andrew Sloan Draper became president in 1894.

Rapid expansion

After 1894, the University began expanding rapidly. Most remarkable was the growth in the College of Agriculture. In 1894-95, only 9 students were enrolled; 10 years later, there were 332.

The growth in agriculture was due largely to the efforts of Dean Eugene Davenport, who was one of President Draper's first appointees. Dean Davenport reorganized classroom instruction, broadened the investigations of the Experiment Station, improved the facilities, and made some notable additions to the staff. He also persuaded the state's agricultural organizations to support his requests for more appropriations from the legislature.

In 1900 a department of "domestic science" was begun under the direction of Isabel Bevier. This subject had been offered in the past but had been dropped for lack of funds.

All in all, by the early years of this century, the College of Agriculture had become firmly established. The University as a whole had passed its most critical period and years of continuing growth and expansion lay ahead.

The University in 1962

Now nearly 34,000 students are enrolled in the University. Of these, about 23,000 are on the main campus in Urbana-Champaign. Nearly 7,000 are at the undergraduate division in Chicago and the Colleges of Medicine, Dentistry, Nursing, and Pharmacy, also in Chicago; and about 4,000 are enrolled in extramural courses. About 86 percent of all students taking credit courses are from Illinois; the rest come from the other 49 states, the District of Columbia, the Canal Zone, Puerto Rico, and 88 foreign countries.

Through the extramural courses, and also through correspondence courses, publications, field workers, radio, and television, people can learn from the University without coming to the campus. Others may come for short periods to attend special training programs, short courses, demonstrations, clinics, and workshops. These activities are carried on through two agencies — the Division of University Extension, and the Cooperative Extension Service in Agriculture and Home Economics.

Much of the knowledge now available through the University has developed from research both here and at the other Land-Grant institutions. The Illinois Agricultural Experiment Station alone has about 350 active research projects. Some of this research is conducted on 1,183 acres of experimental farms at Urbana; a 5,000-acre experiment station at Dixon Springs in southern Illinois; and experimental fields or farms in 30 other counties. In addition, much basic research is being done in the College's laboratories.

Research in agriculture is only part of the total picture. So much research of all kinds is going on in the University as a whole, that it would be impossible to even mention it all.

The benefits of this research are incalculable. It has been estimated that the development of hybrid corn alone would pay for all the agricultural research that has been done through the years. But other benefits — the cure for a disease perhaps, or a more pleasant home — just cannot be measured in dollars and cents.

Scope of Land-Grant universities

Together, the 68 Land-Grant colleges and universities in this country now enrol 20 percent of the nation's college students, grant 40 percent of all doctoral degrees, train half of all officers in the armed forces, and educated 20 of the 38 living Nobel Prize winners who attended college in this country.

The idea of the Land-Grant universities has been called "America's most popular export." Many underdeveloped countries are anxious to have similar institutions. Through contracts with the federal government, American universities are helping countries throughout the world to fulfill this wish. The University of Illinois, for example, has recently helped India to establish a new agricultural university.

Turner, Morrill, and the other early leaders could not possibly have foreseen the scope and influence of the modern Land-Grant universities. But the reality of today has certainly grown out of the vision and efforts of yesterday.

High-speed, electronic computers open
A NEW ERA IN AGRICULTURAL RESEARCH

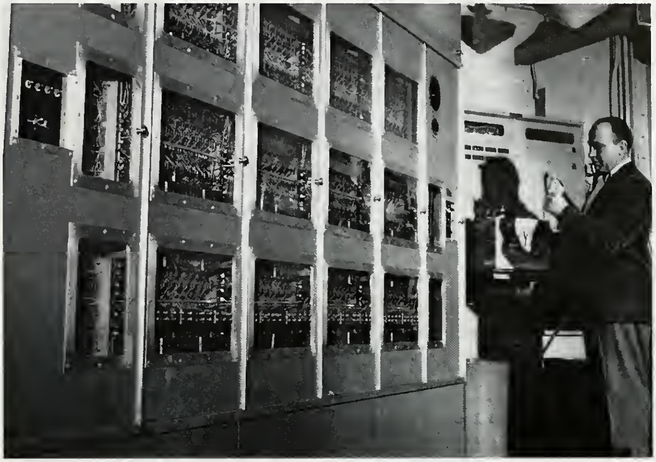
W. C. JACOB

Thanks to the new, high-speed electronic computers, enormous changes have taken place in agricultural research. Projects are now possible that couldn't even have been considered 10 years ago.

The first high-speed computer at the University was completed in 1952. For a few years afterwards, the College of Agriculture used it, but not extensively. Some experience was necessary to realize the potential value of high-speed computers. Since 1954 a concerted effort has been made to use them as much as possible for processing agricultural research data. Now they have become an integral part of the equipment in all areas of agricultural research.

Before the advent of the computers, one great deterrent to agricultural research was the series of problems involved in processing data. Improvements in statistical techniques for designing experiments meant that the quality of data was becoming higher and higher. Unfortunately, the procedures needed to reduce these data to publishable form were also becoming more complex. Research men just didn't have the time to make all the necessary calculations themselves, or even to supervise a clerk operating a desk calculator. As a result, of all the data that could have been collected from one experiment, only a relatively few were taken. And these were only partially analyzed before the experimenter had to go on with the next year's work.

In the Department of Agronomy, for example, a research man will spend most of the summer conducting experiments in the field, taking data, and making observations. During the winter, he will compile the results, analyze them, and write reports of his findings. At the same time he must plan the following summer's experiments. All too often, a few years ago, planting time would arrive before he had fully digested the results of the previous year's work.



W. C. Jacob checks some of the answers given by Illiac, a computer built by the University of Illinois and completed in 1952. In 1944, while in the Navy, Dr. Jacob used the first automatic computer — the Harvard Mark I. He came to the University in 1954 and is now Professor of Biometry and Data Processing in the Department of Agronomy and Associate Head of the Department.

Now, with the use of electronic computers, a research man in Agronomy can usually have a complete statistical analysis of his data within a week or a month after he has completed his experiment. Processing the data takes very little of his time. The work is done largely by the computer and clerical personnel. This frees the research man to interpret results, prepare a report, and plan his next experiment within the limited time available to him.

He now has no hesitation in taking data that require extensive analysis and interpretation. As more and better data are derived from each experiment, progress is faster and the whole research program is improved.

After 7 years' experience in using computers for analyzing agronomic research data, many prepared programs of instructions are available for the machines. Very nearly any analytical job wanted in the Department can now be done on the computers.

The job of recording data has been improved as well. By proper planning, data can be recorded at the experimental site in such a way that a minimum of time and labor is needed to transfer these data into the computers. A portable recorder may be used to put the data on magnetic tape, from which they are later punched onto cards. Or cards are marked with pencil in the field

(mark-sensed) and then are punched by machine at the rate of 100 cards a minute.

Comparisons of the time needed to process data by different methods will give us some idea of the advantages to be gained from using computers. With certain types of problems, which form the bulk of the work now being done by the Agronomy statistical laboratory, one hour on the computer equals about 500 hours on an electric desk calculating machine.

To analyze the data from an average experiment takes 1½ to 2 hours on the desk machine, and then the problem has to be worked again to be sure the answer is correct. The computer will work the same problem correctly in 10 or 15 seconds.

The figures for computer time do not include the time spent in preparing programs of instruction for the machine. Since such programs can be used over and over again, they are considered as a capital investment that should be charged off over a long period of time.

Last year, two statistical clerks processed over 5,000 individual problems, working mostly with the high-speed computers. These two clerks, working full time on desk calculating machines, might have completed 10 problems a day. The time needed to check results would cut average production to five problems a day. This amounts to about a thousand problems a year and probably less as the error rate begins to increase.

It is to the credit of the University of Illinois that a number of forward-looking individuals developed central facilities for handling computing problems. What I have said about the use of computers in the Department of Agronomy could be multiplied many times by other departments, not just in the College of Agriculture but in the whole University as well.

It is not difficult to project that progress will be even more rapid in the future than in the past. As research people become increasingly accustomed to using the new data-processing facilities and plan their work with the high-speed computers in mind, they will learn to utilize these computers more efficiently. The whole program of each department will be improved, and research in general will increase in scope and efficiency.

A portable magnetic tape recorder can be used to record data in the field.

A clerk, while listening to the recording, operates a machine that punches the information into IBM cards. The cards are 7⅜ inches long and 3¼ inches wide.

Sometimes a research man records the data right on the IBM cards, using a high-graphite pencil. The cards are then sensed and punched by the machine shown at upper left. The graphite on the cards causes brushes on the machine to complete an electrical circuit and punch the holes. This machine will also read the holes in one card and punch the information into another card.

Punched cards are fed into the machine above, which prints the information on long sheets. These are sent back to the research man so he can check the accuracy of his data.

Cards are sorted by machine (left) to get them into the proper sequence for the computer. (The holes that have been punched into the cards guide the machine in sorting.)

IBM type 650 computer is shown below. Cards are fed into the part of the computer shown at right. The operator controls the machine at the panel in center. Results are printed on the sheet shown at left.

How good is a fungicide?

DWIGHT POWELL

It's no easy matter to determine the possible value of a chemical for controlling plant diseases. First, we try to make it as toxic to fungi as possible, by juggling the molecular structures of a group of related compounds. Then we study its effects on the metabolic processes of microorganisms.

Compounds that appear promising in these laboratory tests may still be unsatisfactory because of cost, complexity, toxicity to plants or animals, or undesirable physical or chemical characteristics. It is doubtful whether one out of a thousand chemicals that prove fungitoxic in the laboratory ever reach the stage of field tests.

If a chemical survives small-scale, preliminary field tests, then it must be evaluated further. Of the many fungicides now under study in the Department of Plant Pathology, I have selected five—four organic and one inorganic[1]—to exemplify our methods of evaluation.

Dosage response

The first step is to study the responses of fungi to different dosages. Spores of the fungus causing brown rot of stone fruits were used as the test organism. After being washed in sterile, deionized water by centrifugation, the spores were placed on glass slides that had deposits of the chemicals in various concentrations; and the numbers germinating were counted.

One measurement of dosage response is the angle of slope of the dosage response curve. This curve represents the percentage of spores that is inhibited, or kept from germinating, at each concentration of a fungicide. Another measurement is the LD 50 value, or the dosage that will inhibit the germination of 50 percent of the spores.

The angle of slope for each dosage response curve was as follows: dichlone 50W, 85 degrees; captan 50W, 61; dodine 65W, 60; sulfur, 39; zineb 75W, 55. LD 50 values for the same materials were 0.25. 0.50, 0.80, 23.00, and 35.00 p.p.m.

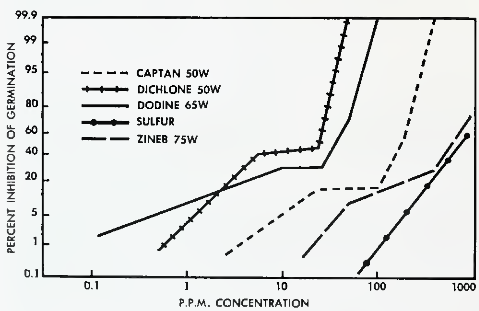
Dichlone, with the lowest LD 50 value and steepest slope, shows the highest innate fungicidal activity. It therefore has a high eradicatory effect when it first comes into contact with a fungus, but it is likely to be unstable, with a low residual effect. Captan and dodine are quite close together in fungicidal response, more stable in residual effects than dichlone, and quite effective as eradicants. Sulfur and zineb, with the highest LD 50 values and the most gradual slopes, show stability, good residual action, and little or no eradicatory properties.

Response after dilution

In the field, fungicide residues are diluted by rain and other water. The effectiveness of the residues was therefore measured after they had been diluted by diffusion through a "water bridge" (Illinois Research, Winter, 1961).

All the materials showed some diffusion toxicity. LD 50 values for the diluted residues were: dodine, 1.9 p.p.m.; dichlone, 2.1; captan, 6.0; sulfur, 70.0; and zineb, 150.0. Dilution increased LD 50 values 2 times for dodine, 3 for sulfur, 4 for zineb, 8 for dichlone, and 12 for captan.

[1] The four organic fungicides, their active ingredients, and the percentage of active ingredient in the formulation are: captan, N-trichloromethylthio-4-cyclehexene-1,2-dicarboximide, 50%; dichlone, 2,3-dichloro-1,4-naphthoquinone, 50%; dodine, n-dodecylguanidine acetate, 65%; zineb, zinc ethylenebisdithiocarbamate, 75%. Sulfur, with 96% active ingredient, was the inorganic fungicide.



Diffusible toxicity of five fungicides against spores of brown rot of stone fruits (*monibinia fructicola*).

Table 1. — Effects of Fungicides on Germination of Apple Scab Spores 1, 5, 10, and 21 Days After Treatment

Fungicide	Days after treatment	Percent inhibition of spores when dosage was—				
		2400 p.p.m.	1200 p.p.m.	600 p.p.m.	300 p.p.m.	150 p.p.m.
Dodine 65W	1	100	100	100	94	80
	5	100	98	98	73	39
	10	100	100	93	80	
	21	100	95	64	50	
Captan 50W	1	100	100	100	87	52
	5	100	100	100	42	12
	10	100	93	4	0	0
	21	98	85			
Dichlone 50W	1		100	78	58	
	5		60	40	0	
	10		0	0	0	
Sulfur	1	0	0	0	0	
Zineb 75W	1	0	0	0	0	

Thus sulfur and zineb continued to show high residual properties. Dodine, which was similar to captan in the first experiment, also showed a high residual potential. Dichlone and captan residues appeared to be more easily weakened by dilution than the other residues.

Dosage response curves of the diluted residues are given in the chart. With increased concentrations of the organic materials, responses were curvilinear. The flat parts of the curves show that germination did not always decrease with increases in concentration. The pattern for sulfur was linear, however, indicating a direct relation between concentration and degree of inhibition.

The ability of a chemical to remain toxic after diffusion through water is not directly correlated with its water solubility. Of the five materials, dichlone has the highest diffusible toxicity, followed by dodine, captan, zineb, and sulfur. But dodine has a water solubility of 600 p.p.m.; zineb, 10; and dichlone, 7. Captan is only slightly water-soluble (less than 1 p.p.m.), while sulfur is considered insoluble. Other factors — such as spore excretions — undoubtedly influence diffusible toxicity.

Tests with apple scab

In another experiment, apple leaves showing lesions of scab disease were dipped in different concentrations of the fungicides in the field. At intervals, the treated leaves were brought into the laboratory and spore viability was determined by germination counts (Table 1).

Dichlone prevented germination when first applied, but the treated spores recovered within 10 days and germinated normally. When applied at the higher concentrations, dodine and captan were eradicative, with no significant recovery of spore viability after 21 days. At lower concentrations, dodine retarded germination longer than captan. Two factors are involved here — the effect of the chemical on the spore and on the mycelial (fungus growth) pad from which spores are produced. At high concentrations both dodine and captan destroyed the mycelial growth, but at low concentrations, dodine was more effective.

Neither zineb nor sulfur inhibited spore germination. Since they are effective in the field, their activity is evidently residual. That is, they must be applied to protect the leaf before infection occurs.

Residual action determined

Residual properties of the fungicides were evaluated by residual analyses and by longevity tests, based on degree of disease control after different spray intervals. On the basis of equivalent dosages, the five materials would rank from high to low in innate residual toxicity as follows: dodine, zineb, captan, sulfur, dichlone.

Unfortunately, innate residual toxicity is not the only factor affecting residual effectiveness. Cost, effect on plants, and other factors determine optimum dosage in the field. For example, dodine gives a better performance than captan when used on an equivalent basis. But considering the many factors involved, the optimum dosage for dodine 65W is ½ pound in 100 gallons of water and for captan 50W, 2 pounds.

Thus, in the field, the active ingredient of captan is 3.1 times as great as that of dodine. Moreover, dodine is more highly surface active than captan. For these reasons, dodine is not as residually effective in the field. The estimated field performance of the five fungicides on apple scab is given in Table 2.

Other factors to consider

Fungicides have a certain amount of specificity. That is, they are more toxic against some organisms than others. However, there is relatively little correlation between the type of specificity shown in the laboratory and that in the field. For example, in the laboratory dodine and captan are almost equally effective against the pathogen causing brown rot of stone fruits. In the field, captan controls the disease fairly effectively — dodine not at all. Captan is fungicidal in the acid medium of the fruit, but dodine is not.

Table 2. — Estimated Field Control of Apple Scab by Five Fungicides

Fungicide and optimum dose in 100 gal. water	Percent of spores controlled by—		
	Inhibitory action	Eradicative action	Protective action
Captan 50W, 2 lb.	10	30	60
Dichlone 50W, ½ lb.	100	0	0
Dodine 65W, ½ lb.	10	60	30
Sulfur, 8 lb.	0	0	100
Zineb 75W, 2 lb.	0	0	100

Temperature may affect fungicide usefulness. Dichlone can be used only in the cool months of early spring. During hot weather it disintegrates rapidly, loses its fungicidal activity, and injures the plants. Sulfur is also injurious in hot weather. Dodine, on the other hand, may cause fruit russet on Golden Delicious apples if temperatures are low (A. E. Mitchell, Michigan Agricultural Experiment Station).

A thorough knowledge of the pathogen (such as disease cycle, optimum temperature for growth, and mode of infection) is necessary to obtain maximum performance of a fungicide. The apple scab pathogen, for example, causes a superficial lesion on the surface of leaves and fruits, and spores develop in the open, where they are highly susceptible to both eradicant and residual action of a fungicide. The strawberry leaf scorch pathogen enters the leaf only from the under surface; the germ tube grows and develops inside the leaf, finally causing a lesion on the upper surface. New spores are developed in well-imbedded fungus structures called acervuli. So we must depend on residual rather than eradicative action for control.

All these considerations add up to the fact that a well-planned research program is necessary to answer the question, "How good is a fungicide?" And then our answer must have many qualifications.

Dwight Powell, Professor of Plant Pathology, has been with the University since 1939.

HOW FARM TRACTORS ARE USED

J. A. WEBER

The cost of operating a farm tractor depends partly on how well it's designed for the work to be done. There has been little specific information, however, on the actual use of tractors by farmers. This is due to the wide diversity in the use of farm tractors and the difficulties of obtaining good field records.

As part of a tractor project sponsored by the Illinois Farm Supply Company, the Department of Agricultural Engineering has measured engine horsepower outputs for farm operations, using one test tractor; and cooperating farmers in Champaign county have kept records on the daily use of 25 tractors for a year.

Test tractor in farmers' fields

The test tractor was instrumented to record engine speed and manifold vacuum (Fig. 1). These recordings were converted, by dynamometer calibration, into engine horsepower output.

Cooperating in the test were 12 farmers who had equipment suitable for use with the test tractor. This tractor was substituted for the farmers' tractors over long enough periods to obtain records for such operations as plowing on fields of varying condition.

Some typical results for 19 field operations are shown in the table. Operations that farmers generally consider heavy work took from 57 to 97 percent of maximum horsepower.

J. A. Weber, Associate Professor of Agricultural Engineering, did both his undergraduate and his graduate work at the University of Illinois and has been on the staff since 1946.

Records kept by farmers

Records from the 25 farmers' tractors showed that 23 operations accounted for practically all the operating time. Figure 2 shows the average number of hours spent on each of these operations in a year. The 25 tractors were used an average of 340 hours per year, the range being from 164 to 627 hours. These values are noticeably lower than those reported in previous studies, but there are a number of reasons for these differences.

The tractors in this study were picked at random and were not necessarily new. Another Illinois study, begun with 50 new models in 1955, showed a decided drop in hours of use as the tractors became older. Average use for the 50 tractors was 625 hours in 1955; 498 hours in 1958. If there is more than one tractor on a farm, an older tractor is used less often because it lacks newest conveniences. Other factors reducing tractor use are the increased horsepower in new tractors and the greater use of self-propelled equipment.

The number of hours a tractor can be used annually is also affected by seasonal requirements. In the cash grain area, about 60 percent of the tractor use is in April, May, and June, while there are several months in which the tractor is used very little (Fig. 3).

Information put to use

Operating characteristics of the test tractor were determined by dynamometer test, and Figure 4 shows how the hand throttle can be set to reduce engine speed and yet maintain a constant output of horsepower. Lines of constant specific fuel consumption are also shown, the lowest specific fuel consumption being the highest efficiency. This chart

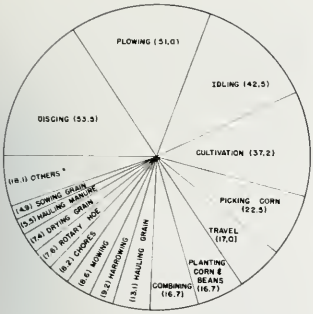
Instrumentation of test tractor. (Fig. 1)

shows how shifting up in gear ratio and throttling down to a lower engine speed will reduce specific fuel consumption for a constant horsepower output. Cooperating farmers operated at reduced engine speeds for light loads and for operations requiring low ground speeds.

Horsepower and engine speed requirements as determined by the test tractor were combined with the records from the 25 tractors to find out how many hours the "average" tractor would be operated at the many horsepower and speed combinations that are available. Figure 5 shows the distribution of the 340 hours of average tractor operation a year. For example, the average tractor was used 14 hours between 30 and 35 horsepower and 1500 and 1600 rpm.

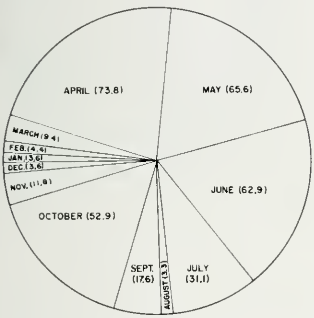
This study highlighted the importance of part load fuel efficiency, for the average load for a year was only 54 percent of maximum horsepower of the tractor.

Information from this and similar studies provides some insight into farmers' use of tractors and gives engineers a basis for improved design. For example, Figure 5 has been used to evaluate the redesign of a tractor carburetor for better part load efficiency and to set a dynamometer load cycle for endurance testing of spark plugs and valves.



Number of hours an "average" tractor is used for various farm operations — based on records for 25 tractors. (Fig. 2)

* Other operations include shredding stalks, 4.2 hours; fertilizer application, 3.7; baling hay, 3.2; spraying, 2.5; field cultivation, 1.5; clearing snow, 1.2; shelling corn, 0.7; raking, 0.7; chopping hay, 0.4.

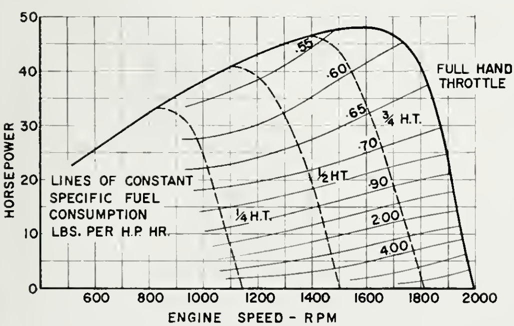


Number of hours an "average" tractor is used each month — based on records for 25 tractors. (Fig. 3)

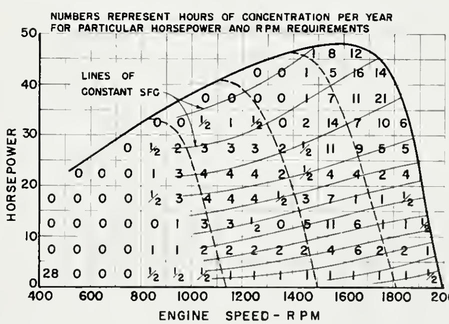
Typical Power Requirements for Farm Operations

Operation and average horsepower[a]	No. of tests	Av. hp.	Pct. full hp.	Speed, m.p.h.
Plow — 4-bottom (41.57)				
Stalk ground, mtd. with trail wheel, slatted moldboard	13	39.6‡	81.5	3.8
Sod ground, mtd. with trail wheel, slatted moldboard	6	45.0‡	92.5	3.3
Field cultivator (41.25)				
Bean ground, 10-12-in. sweeps, 2-section harrow, 6-in. depth	2	42.3	87.1	4.6
Plowed sod, 10-12-in. sweeps, 2-section harrow, 4-in. depth	5	41.0	84.4	4.7
Rotary hoe (40.12)				
Hoeing corn, 4-section	2	47	96.8	12
Hoeing small corn, 600 lb. wt. added, 4-section	3	44.7	92	12
Hoeing small corn	7	27.9	57.4	10.1
Cultipacker — Plowed ground, 9 ft. width	3	37.7	77.6	4.6
Spike-tooth harrow (35.3)				
Plowed ground, 20 ft. section	7	35.7	73.4	5.63
Spring-tooth harrow — plowed ground, 12 ft. width	5	33.5†	68.9	5.73
Disk (33.41)				
Alfalfa plowed, but not harrowed, 9 ft. tandem wheel type	2	38.3	78.8	4.55
Stalk ground, spike-tooth-harrowed once, 13 ft. tandem	9	37	76.1	3.99
Plowed ground, 11 ft. tandem	5	32.6	67.1	4.55
Cornstalk ground not plowed, 9 ft. tandem	3	27.4	56.4	4.7
Corn picker (26.98)				
Pull type, 2-row	12	30.96	63.6	2.67
Picker not running, just pulling full wagon	1	23	47.3	2.65
Chopper (24.5)				
Alfalfa hay, standing, 5 ft. width	1	28.3	58.2	4.6
Alfalfa hay, cured, 6 ft. width	7	20.7	42.5	3.38
Ammonia applicator				
Disked plowed ground, 5 knives, 1,000-lb. tank	4	26.6	54.7	4.7
Cultivator (21.05)				
Knee-high corn, 4-row	6	25.5	52.4	4.95
Corn planter (18.1)				
Large hoppers, furrow openers, 4-row	4	26.6	54.7	5.58
Standard hoppers, furrow openers, 4-row	7	21	43.2	6.25
Subsoiler — Bean ground in which water stood	8	16.25	34	3.6
Crusher and mower operated together (15.5)				
Alfalfa brome, 7 ft. machine	4	19.4	39.9	4.9
Combine — Wheat standing, 5 ft. machine	8	13.9	38.6	1.85
Crusher — Alfalfa brome, 7 ft. machine	3	12.7	26.1	4.9
Mower — Alfalfa brome, 7 ft. crusher using only the mower	1	11.75	24.2	3.6
Rake — Alfalfa brome, steel-wheeled rake	2	9.9	20.4	7.45
Travel — Pulling implements in from field	3	6.2	12.7	7.08

[a] Average horsepower for all test runs for operation is given in parentheses.
†, ‡, Respectively groups of tests containing one and two overloads. "Overload" means that the engine is producing less than maximum horsepower (48.6) but is developing more torque than at maximum horsepower.



Specific fuel consumption of test tractor for all possible power requirements. (Fig. 4)



Concentration of hours of use compared with specific fuel consumption of test tractor. (Fig. 5)

A good manager makes
A GOOD BORROWER

DONALD G. SMITH

MOST FARMERS are borrowing more than ever before. The rapid technological development in farming has meant larger farms, a greater volume of business, higher operating expenses, and intensified operation. All these trends call for more and more operating money.

On the basis of volume of non-real-estate loans outstanding, commercial banks are the most important institutional lenders to agriculture. Through their loans they create "new money" which helps not only the farmers but the whole trade area as well. The banks can also guide the borrower in the productive use of the additional capital.

Purpose and scope of study

Farm credit operations and farm management are closely interrelated. With the increased need for capital goes a need for better management. But just which management practices are likely to spell success in the use of borrowed capital?

It was this question that led to the present study. Objectives of the study were: (1) To determine differences in management between tenant-operator borrowers who have shown financial progress and those who have not. (2) To determine the characteristics that bank officers look for in a prospective borrower.

The study covered the 5-year period from 1955 through 1959. During this time the number of farms in Illinois decreased by 20,903. Operator's realized net income per farm in Illinois averaged $316 per year less in this period than in the previous 5 years. Living expenditures also went up during the period, causing additional financial stress.

Data for the study came from the farm financial records of 59 farm customers of six Illinois banks. The figures were supplied in confidence by agriculturally trained officers of the six banks. Together, the six officers had over 68 years of farm credit work behind them.

The banks all feature one-stop banking and budgeted loans. Two are in the northern part of the state, one in the northeast, two in the west, and one in east-central Illinois. All are in areas of high land values. Resources are similar enough in the different locations to permit comparisons among the areas.

Two groups of operators

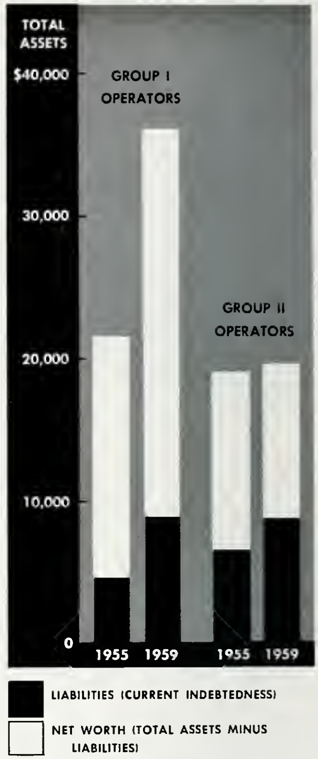
Of the 59 operators in the study, 30 showed financial progress (increased net worth) and 29 showed no progress (decreased net worth). In personal characteristics, background, and education, the two groups were quite similar. Both groups averaged about 36 years of age in 1955, and had been farming about 13 years.

Group I operators had more net worth to start with than Group II operators (Fig. 1). This greater net worth was, of course, an important advantage and no doubt affected the operators' management decisions.

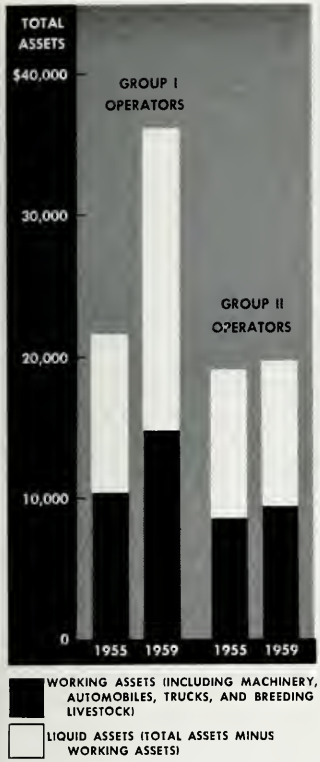
By the end of the period, Group I operators had substantially increased their volume of business. Starting out with 48 acres more per farm than Group II, they increased their farmland by an average of 25 acres. Group II farms, however, grew smaller (see table).

Group I operators placed major emphasis on enterprises with a relatively high return per hour of labor. During the 5-year period they increased their high-cash-value crops, hogs, and beef more than did the other group (see table). For example, they increased their acres in corn and soybeans by 32 percent; Group II operators increased theirs by only 14 percent. Even with a greater increase in corn and soybeans, Group I operators had only 68 percent of their land in these crops.

Donald G. Smith, Assistant Professor of Agricultural Economics and manager of University Trust Farms, has been with the University since 1958. He was previously farm manager at the First Trust & Savings Bank of Kankakee.



Net worth and liabilities, in 1955 and 1959, of tenant operators showing financial progress (Group I) and those not showing progress (Group II). (Fig. 1)



Changes in the composition of assets owned by the two groups of operators. Liquid assets are those readily converted into cash. (Fig. 2)

Group I operators increased their machinery investment $2,652 more than the other group. This increase reflects the need for more or better machinery to keep labor employed profitably, as well as the higher cost of replacement machinery.

Working assets increased in both groups (Fig. 2). Group I operators increased their liquid assets considerably, however, while Group II operators lost slightly in this respect.

Management ability rated

The bank officers were asked to rate their borrowers' over-all management ability. These ratings would have to include such measures of efficiency as yield per acre; returns per $100 of feed fed; and machinery, fertilizer, and labor costs per acre. Since such factors do not ordinarily show up on the financial statement, the bank officer analyzes them through farm visits, interviews, and inspection of farm records.

In rating the borrowers, the bank officers used a scale from 1 to 10, with 1 being poor and 10 excellent. Group I operators averaged 7.7; Group II, 4.0.

Land, Livestock, and Machinery Resources in 1955 and 1959

Item	Group[a]	1955	1959
Soil productivity rating	I	82	82
	II	81	81
Acres per farm	I	266	291
	II	218	214
Acres of corn and soybeans	I	151	199
	II	122	139
Value of livestock, dollars	I	6,494	15,898
	II	5,414	6,818
Value of machinery, dollars	I	8,420	11,944
	II	7,169	8,041

[a] Group I includes 30 tenant operators that showed financial progress between 1955 and 1959; Group II, 29 that showed no financial progress.

Characteristics considered

Following are some points that the bank officers said they used when rating a borrower.

Personal characteristics

Does the borrower have a good, morally sound character?

Is his over-all business and personal management good?

Is he happily married?

Is his wife cooperative?

Does she come into the bank and is she in on plans?

Is he thrifty in his personal spending?

Is he frank and cooperative?

Does he have the education and experience to be a good farmer?

Is he progressive without being radical?

Can he adapt to changes?

Is he timely in his farm operations?

Is he neat?

Is he a stay-at-home farmer?

Credit management

Does he respect due dates?

Does he use one source of credit?

Is he careful not to overborrow?

Purpose of loan

Net worth (financial position)

Capacity to pay

Does he have a positive plan of operations?

What is his repayment potential?

What is the capacity of his farm operation?

What is his volume of business?

Is he fully employed?

Crop management

Does he have a balanced program between livestock and grain?

Can he produce high crop yields?

Does he use fertilizer intelligently?

Does he keep weeds controlled?

Livestock management

Does the livestock program fit the farm?

Can he feed and care for hogs?

Does he have a definite breeding program for livestock?

Does he know how to buy, feed, and sell feeder cattle?

Does he follow a sanitation program?

Machinery management

Is he a good machinery man?

Can he control machinery costs?

Does he buy only what he needs?

Does he repair machinery when he puts it away or when it is not in use?

One bank officer takes five overall factors — the man, the financial position, the purpose of the loan, the repayment schedule, and the collateral — and rates them plus and minus. He then adds up the pluses and minuses as a rough guide to whether the loan should be made.

A borrower must be credit-rating conscious. The points listed by the six bank officers spell out the traditional three C's of credit — character, capacity, and collateral. They not only are a guide to what a loan officer wants and expects, but also indicate what it takes to do a good job of farming.

Need for good management

Credit should be based on a sound farm plan. Effective use of capital is the responsibility of both borrower and lender. Collateral and security may make the loan easier to obtain and handle, but capital productivity is what makes the wheels go round. The importance of good management increases with the need for more capital.

The PROTEIN REQUIREMENTS of LAYING HENS

Hens will produce well on a diet relatively low in total protein, provided it contains the right combination of the essential amino acids

D. J. BRAY

D. J. Bray (left) checks one of the pullets in the experiment. When Dr. Bray first came to the University in 1954, he was in Extension work, but he is now engaged in research and teaching. He is Associate Professor of Animal Science.

How much protein does a laying hen need? When we try to answer this question, we run into a variety of opinions and recommendations.

According to the National Research Council, laying rations should contain 15 percent protein. All-mash rations fed in commercial operations range from 14 to 20 percent in protein content. Experimental findings have shown that as little as 12 percent is needed under some conditions, while 18 percent may be needed under other conditions.

No "one" protein

Part of the difficulty stems from the fact that proteins contain varying proportions of the different amino acids. One protein source might be high in one amino acid but low in another; while the reverse might be true of another protein.

Since the laying hen needs a number of amino acids in certain proportions, the problem is not just to meet a total protein requirement, but to combine protein sources so that they will provide satisfactory proportions of the amino acids.

The problem is similar to the one of providing vitamins. It has long been accepted that the vitamin requirement of the bird is not one amount of total "vitamin" in the diet. Rather, specific vitamins are needed, each at a certain concentration. If a vitamin supplement should be low in a vitamin that the bird needs at a relatively high level, then large amounts of the supplement would have to be fed to make the ration adequate in all vitamins. This means that the hen would get more of some vitamins than she needs.

Recognizing these facts, the feed industry today manufactures vitamin supplements that are "tailor-made" to provide adequate amounts of all vitamins without feeding needless and costly excesses of some vitamins.

Unfortunately, our knowledge of the laying hen's requirement for each amino acid has not yet progressed to the stage where we can prescribe a "tailor-made" protein. So we tend to feed high-protein rations to make sure the hen gets enough of all the amino acids.

Corn and soybeans as sources of amino acids

The Poultry Division has recently been studying the value and limitations of various combinations of corn and soybean proteins as sources of amino acids for laying hens. These two proteins were chosen for study because of their present availability to the Illinois poultry industry.

The amino acid contents of egg, corn, and soybean protein are shown in Table 1. Compared with the egg protein synthesized by the hen, corn protein is low in lysine, tryptophan,

Table 1. — Amino Acid Content of Egg, Corn, and Soybean Proteins

Amino acid	Percent of protein in—		
	Egg	Corn	Soybeans
Lysine	6.9	2.7	6.6
Tryptophan	1.6	0.7	1.2
Isoleucine	6.9	4.0	5.8
Methionine and Cystine	5.6	3.4	2.3
Valine	7.4	5.3	5.2
Threonine	5.0	4.1	3.9
Phenylalanine and Tyrosine	9.9	9.1	8.0
Histidine	2.4	2.4	2.5
Leucine	9.4	12.7	7.6

and isoleucine. Methionine and cystine appear to be the most deficient amino acids in soybean protein.

Soybean protein, however, is relatively rich in lysine, tryptophan, and isoleucine, the amino acids that are low in corn. And corn protein contains more methionine and cystine than soybean protein. This suggests that a mixture of corn and soybean protein would provide a better combination of amino acids than either one alone.

Trials with pullets

To test this hypothesis, six rations were devised with varying proportions of corn and soybean protein (Table 2). After a ration was adjusted to contain a certain level of total protein, it was filled out with corn starch, which is pure carbohydrate and contains no protein. Six groups of 20 pullets each were fed these rations for 12 weeks.

Of the six rations, five were 10 percent protein. At this protein level, the best egg production resulted when soybean meal provided either 42 percent or 61 percent of the total protein. The rate of lay was decreased by increasing the soybean protein to 81 percent or 100 percent of the total protein, or by lowering it to 22 percent.

A regression analysis of the data indicated that the birds would lay the maximum number of eggs if 55.5 ± 2.8 percent of the protein originated from soybean meal. This same type of experiment has been repeated several times with essentially the same results.

Supposedly, the minimum deficiency of any one amino acid occurred when soybean meal provided 55 percent of the protein. The data in Table 1 suggest that when soybean meal provides more than 55 percent of the protein, methionine and cystine are the amino acids most likely to be deficient.

This view is substantiated by an experiment conducted in our laboratory: Over a 12-week period, pullets' rate of lay was increased from 43.5 to 72.8 percent merely by adding 0.15-percent DL-methionine to a 10-percent protein ration in which soybean meal provided all the protein.

Conversely, when soybean meal provided only 20 percent and corn 80 percent of the protein in low-protein rations, supplemental tryptophan and lysine increased the rate of lay. This result was also predictable from the data in Table 1.

Table 2. — Rate of Lay of Pullets Fed Graded Combinations of Corn and Soybean Protein for 12 Weeks

Percent protein in ration	Percent of protein from—		Percent production
	Soybean meal	Corn	
16	61	39	75.4
10	100	0	38.8
10	81	19	49.7
10	61	39	59.0
10	42	58	60.0
10	22	78	45.8

Table 3. — How Proportions of Protein From Corn and Soybean Meal Vary With Changes in Total Protein of Ration

Percent protein in ration	Percent of protein from—	
	Soybean meal	Corn
10	23	77
11	32	68
12	40	60
13	46	54
14	52	48
15	57	43
16	60	40
17	64	36
18	67	33

Formulation of rations

When formulating a practical corn-soya laying ration, we increase the protein level by replacing corn with soybean meal. The proportions of corn protein and soybean protein in rations with varying levels of total protein are shown in Table 3.

Only 23 percent of the protein is provided by soybean meal in a 10-percent protein ration, while 67 percent comes from this source in an 18-percent ration. The best combination of corn and soybean protein is in rations containing 14 to 15 percent protein. Soybean meal provides about 55 percent of the protein in this range.

From this point it can be reasoned that birds fed rations containing more than 15 percent protein may respond to methionine supplementation, while those fed rations containing less than 14 percent protein may respond to lysine and tryptophan supplementation.

These observations provide one basis for explaining the varied results obtained from supplementing corn-soya laying diets with methionine and lysine, the two amino acids that are now available commercially.

A desirable combination of amino acids

These and other studies in our laboratory indicate that good egg production can be obtained on rations with a low level of protein, provided the proportions of amino acids are similar to those found in eggs.

As already mentioned, pullets maintained a 72.8-percent rate of lay for 12 weeks when fed a diet that was 10 percent protein (all furnished by soybean meal), supplemented with 0.15-percent DL-methionine. This level of supplementation increased methionine and cystine from 2.3 percent to 3.8 percent of the protein. As will be noted from Table 1, the levels of the other amino acids in soybean protein are similar to the levels found in egg protein.

Hens need amino acids to maintain feathers and other tissues as well as to produce eggs. So these needs must also be considered in establishing the amino acid requirements of laying hens.

The ultimate aim of research in this area is to learn how the proteins in feeds can be more efficiently converted into proteins suitable for human consumption. Although our research was done with corn and soybean meal, the principles that have been brought out should apply to the formulation of any laying ration.

New program of GRADUATE STUDY for EXTENSION WORKERS

E. W. ANDERSON

A NEW DEGREE — "Master of Extension Education" — has been proposed at the University of Illinois. The degree program was developed by a study committee appointed by Dean Howard.

Even if the present proposal is not accepted, the committee believes that the underlying philosophy and the general concepts of the proposal are sound for any accepted program. It therefore seems worthwhile to report here, in general terms, the philosophy behind a professional degree for Extension workers and to explain the broad plan of the program.

In developing the program, the study committee kept in mind certain principles. The primary one is that any educational program should furnish an individual the opportunity to develop in knowledge or concepts, attitudes, and skills — in short, to grow as a person and better understand himself and his environment.

Learning is most likely to be retained and used if it has personal meaning and significance. Random learning may not be meaningful.

A professional degree program

The proposed program is a professional degree program, designed to promote breadth of study, and not a research degree program. Planned for a person who is working in, or plans to enter, the field of Extension education, it allows for wide individual differences in background, needs, and interests.

Half the credit is earned in technical subject matter. This allows the experienced worker to catch up with changes in agriculture or home economics, and gives the new worker opportunity to broaden or deepen his technical knowledge.

The other half of the credit courses are earned in the social sciences. To "help people help themselves," Extension workers have to work with people, singly or in groups. This calls for understanding and skill in psychological and sociological processes. These educational needs are often less apparent than the need for additional technical information. But when Extension workers have failed, it has often been acknowledged that they "couldn't get along with people."

As is true of many professional degree programs, a student may take an extra unit of course work instead of submitting a thesis.

Depth of program from existing courses

Unlike similar programs for Extension workers at other universities, the proposed program at Illinois does not include any special courses. Instead, it will rest on existing courses that have already met the academic requirements of the Graduate College and of the departments concerned, and whose scholarly depth is established. The student, under the guidance of his adviser, has great latitude in selecting his courses so he can meet his individual needs.

E. W. Anderson, Professor of Agricultural Extension, has charge of education for Extension workers. A colonel in the U. S. Army Reserves, he is also Coordinator of Command and General Staff College courses in the Champaign USAR School.

Once the program is underway, a need may develop for a special course that would tie the abstract principles of many courses into a meaningful, practical program. If such a need arises, a course can be organized in one of the subject matter departments of the university.

Administrative details

The program will be administered by a committee appointed by Dean Howard. This committee will have the same administrative relationship with the Graduate College as a subject matter department. It will help a student select an adviser, who will not only guide the student in the selection of courses but will also be in charge of thesis research, if the student selects the thesis option.

Residence requirements are met by a minimum of four units earned on the Urbana campus. Total extramural courses cannot exceed three units.

COMING EVENTS

(A partial list of meetings scheduled at Urbana)

Jan. 24-25: Custom Spray Operators' Training School

Jan. 30-31: Agricultural Industries Forum

Jan. 31-Feb. 1: Illinois Nutrition Conference

Feb. 1-2: Annual Winter Meeting, Illinois Society Professional Farm Managers and Rural Appraisers

Feb. 2-4: Rural Youth Winter Rally

Feb. 5-Mar. 16: Winter Short Course in Agriculture and Home Economics

Mar. 13: Illinois Swine Growers' Day

Apr. 13: Illinois Cattle Feeders' Day

College of Agriculture offers
TRAINING FOR MANY KINDS OF JOBS

K. E. GARDNER

AGRICULTURE, in the year 1962, is our largest industry, accounting for 40 percent of all private employment in this country. It is not merely farming, but farming *plus!* In its entirety, the industry includes three main segments.

1. **Producers of food and fiber** — ranchers, farmers, orchardists, dairymen, market gardeners.

2. **Suppliers and service industries** for agriculture — educators, research workers, and producers and suppliers of feed, fertilizers, seed, insecticides, herbicides, farm machinery, and farm equipment.

3. **Processors and distributors** of food and fiber.

Collegiate agricultural education

The multiplicity of jobs in agriculture calls for trained and educated people. To help students prepare themselves for these jobs, the College of Agriculture now offers 24 principal courses of study. Just a mere listing will show some of the diversity:

Agricultural Communications . . . Agricultural Economics . . . Agricultural Marketing . . . Agricultural Mechanization . . . Animal Science . . . Crops . . . Dairy Science . . . Horticulture . . . General Agriculture . . . Agricultural Industries . . . Agricultural Science . . . Agricultural Engineering (5 years) . . . Agriculture and Law (6 years) . . . Dairy Technology . . . Farm Management . . . Floriculture . . . Food Technology . . . Forest Production . . . Wood Technology . . . Horticultural Food Crops . . . Rural Sociology . . . Soils . . . Restaurant Management . . . Vocational Agriculture (for prospective high school teachers).

K. E. Gardner is Associate Dean of the College of Agriculture and Professor of Nutrition in the Department of Dairy Science.

A university education in agriculture is not merely vocational or technological training — it is education in breadth as well. Most students take 20 to 40 percent of their courses in the College of Agriculture, and the remainder, depending on a student's specialization or curriculum, in the Colleges of Liberal Arts and Sciences, Commerce, Engineering, Law, or Veterinary Medicine.

Calibre and background of students

The calibre of students now enrolled in the College of Agriculture is very good, as judged both by their rank in high school and their progress in the University. To meet the demands of the total agricultural industry, the College of Agriculture needs to continue attracting top-notch students.

There is room in agriculture for intelligent students from all walks of life. The feeling that only the boy from the farm can succeed in agriculture is utter nonsense. A look at the courses of study, listed above, will show that many require absolutely no farm background.

At present, 70 percent of our students come from rural areas, but in some colleges across the land the percentage is under 50. I would say that in such states urbanites are more alert to the opportunities in the total field of agriculture.

Science and agriculture

Many of the opportunities in agriculture are for people who have a sound knowledge of science. Back in 1890 the University catalog stated, "Agriculture involves a larger number of sciences than any other human employment." This statement is even more true now than it was 70 years ago. It would be difficult to list more than one or two of the known sciences that are not involved in some way in the field of agriculture. Certainly no other industry can make this statement.

Science is demanding, and the student who is interested in agricultural science must be prepared to go through a strict apprenticeship in the basic sciences. Our Agricultural Science curriculum has shown increasing strength — as it should.

Agricultural industries

While only 5 percent of the students in the College of Agriculture are at present enrolled in the Agricultural Industries curriculum, the number has increased rapidly during the two years since this curriculum was introduced. We expect that ultimately a third of our graduates will find themselves in businesses and industries.

According to a 1960 survey of alumni, the average salary of 931 graduates in business was $11,500. Since this includes not merely those who have "arrived," but those who are entering the field, a man apparently has room to grow in this area of agriculture.

Farming still important

With all the increasing emphasis on science and business, we do not down-grade the importance of farming at the College of Agriculture. About 25 percent of our graduates do go into farming, and their income is impressive.

President Andrew Sloan Draper's statement, "The wealth of Illinois is in her soil and her strength lies in its intelligent development," is just as true now as when he said it in 1900. It is important, however, that the citizens of the state learn to think of agriculture in its totality.

RESEARCH IN BRIEF

Some Effects of Different Sugars in Foods

The various sugars commonly found in foods differ greatly in their sweetness. There is no exact test for sweetness, and the relative sweetness of different sugars may vary with such factors as concentration, temperature, and the presence of additional flavors. It is generally accepted, however, that the order of decreasing sweetness of the most common sugars is fructose, sucrose (ordinary cane and beet sugar), glucose, and lactose; and that fructose and lactose differ enormously. It is therefore conceded that one sugar can seldom be substituted directly for another without altering the flavor of the resulting product.

Less recognized is the fact that the texture of the product often changes as the result of such substitution. In the Department of Home Economics, different concentrations of some of the more common sugars have been added to starch-water and gelatin-water mixtures, and a variety of results have been observed.

When sugar concentrations were very small, comparable to that of lactose in milk, their influence on starch-water mixtures, in the absence of other ingredients, was almost negligible. However, at higher concentrations, comparable to that of sucrose in starch puddings, differences among the common sugars were striking. The cooking time required for the starch-water mixture to reach its maximum viscosity was increased slightly by dextrose or fructose, but was more than tripled by sucrose or lactose.

At the higher concentration, both dextrose and sucrose greatly reduced the viscosity of the starch paste after cooling and the strength of the gel formed after its storage under refrigeration. Sucrose had an appreciably greater effect than an equal weight of dextrose.

Increasing concentrations of both dextrose and sucrose were found to decrease the strength of gelatin gels. The two sugars seemed to have about the same effect, in contrast to their differing behavior with starch gels. They also appeared to increase slightly, and almost equally, the melting point of the gel.

It must be concluded that the effects of sugars on other food ingredients differ greatly, depending both on the particular sugar and on the other food ingredient. — *Elizabeth Osman*

Insurance Purchases by Illinois Farm Families

The purchase of insurance is one method whereby Illinois farmers protect themselves against possible losses from fire, wind, hail, and other causes. For a group of 39 central Illinois farms, the average insurance bill paid in 1960 by the farm business totaled $779. These farms had an average gross farm income of $31,888.

Expenditures for different types of insurance were:

General liability coverage	$ 50
Fire and windstorm on buildings	124
Fire and windstorm on contents of buildings	90
Hail insurance on growing crops	393
Automobile insurance	84
Truck insurance	38

In addition to insurance on business risks, farm families invest in life insurance. Data on this form of insurance have been obtained from the 1960 home-account records of 98 Illinois farm families. These families had an average gross cash income of $19,998, including $18,801 from farm sales. Their life insurance expenditures averaged $347.

Families with a gross income ranging from $10,000 to $24,999 spent $307 for life insurance. Those with gross incomes between $25,000 and $49,999 spent $468. — *A. G. Mueller*

Vaccination Tried for Shipping Fever of Cattle

The virus of bovine para-influenza 3 has been incriminated as one cause of shipping fever of cattle. The College of Veterinary Medicine has therefore been conducting experiments to determine whether vaccination with inactivated bovine para-influenza 3 virus will help prevent shipping fever.

One experiment involved 87 Hereford calves — 43 steers and 44 heifers. In October, 1959, when they were 7 to 9 months old, they were separated from their dams at a Texas ranch and trucked to a stockyard 35 miles away. There they were weighed and half the calves received an intramuscular injection of 10 ml. of formalin-killed, bovine para-influenza 3 vaccine (tissue culture origin), while the other half were injected with a placebo (an inactive preparation). Calves were bled and ear-tagged, and then loaded into two cattle cars.

They reached northern Illinois in good condition, having been fed once en route. Upon arrival at the feedlot, they were weighed and bled. Weight shrinkage amounted to 8.24 percent. For the first 3 weeks after arrival, they were fed 1½ pounds of oats per head a day and alfalfa-timothy-brome hay free choice. Then the oats were increased to 6 pounds a head.

The cattle were observed daily for signs of shipping fever, including depression, labored breathing, nasal discharge, cough, and lack of appetite. Calves showing signs were isolated and their rectal temperatures taken before treatment by the local veterinarian. Nasal swabs were collected as soon after treatment as possible.

None of the calves had developed blood antibodies against the para-influenza virus before shipment. One vaccinated calf and two unvaccinated calves had such antibodies at

the time of unloading. Thirty days later, 53.5 percent of the vaccinated calves and 72.7 percent of the unvaccinated calves had developed antibodies against this virus.

Nine of the vaccinated calves and five of the unvaccinated calves showed signs of shipping fever, including rectal temperatures of 104° to 107° F., depression, cough, and a nasal discharge. Bovine para-influenza virus was isolated from 7 of the 14 calves. Eight of the calves had developed antibodies for this virus. None, however, had developed antibodies for the virus of infectious bovine rhinotracheitis. *Pasteurella multocida*, a bacterium often associated with shipping fever, was isolated from a nasal swab of one vaccinated calf that had signs of shipping fever.

The isolation of bovine para-influenza 3 virus from 7 of the 14 calves with signs of shipping fever, supports previous findings that this virus is associated with shipping fever. The fact that more cases of shipping fever developed in vaccinated calves than in unvaccinated calves may be due to the stresses of long-distance shipping after vaccination.

In other experiments, vaccination of cattle with two doses of killed para-influenza 3 vaccine before weaning had some value.

On the basis of these experiments, we cannot recommend vaccination at the time of shipment. However, vaccination of feeder cattle 2 weeks before shipment would seem advisable. — *G. T. Woods, S. K. Sinha, C. A. Brandly*

Wrinkle Resistance of Fabrics During Laundering

Most research in the Division of Textiles and Clothing concerns either the care of textile products or the behavior of different fabrics in varying situations. Some of our research, however, is done to develop new testing methods. An example is our efforts to find new ways of testing fabrics for their wrinkle resistance during laundering.

The textile industry has used a dry wrinkle recovery test for 20 years to indicate the wrinkle resistance of a fabric during use. The test, however, is not a good indication of a fabric's wet wrinkle recovery, or its resistance to wrinkling while being washed. Consequently, a task group of Committee D-13 on Textiles of the American Society for Testing and Materials started work on developing a test for measuring wrinkle recovery of wet fabrics.

The University of Illinois work was done to give the task group some information concerning the effects of various factors on the wrinkle-recovery ability of the fabrics. These factors included the method of putting the wrinkles in the fabrics, temperature of the water, and amount of water absorbed by the fabrics. The fabrics tested included a non-wrinkle-resistant cotton, two wrinkle-resistant cottons with different types of finishes, a rayon, a nylon, a Dacron, and an Orlon.

After a recommended procedure was developed, it was tested by seven other laboratories to see whether the results could be duplicated. — *Ruth Legg Galbraith and Patricia Cunningham Bevilacqua*

Bagworms — a Potential Hazard in Illinois Pine Plantations

In the past bagworms (*Thyridopteryx ephemeraeformis* (Haworth)) have been considered of minor importance in Illinois, although they can defoliate a variety of trees. However, they may become a problem in the future management of pine plantations.

Every year more infestations are occurring. Among the pines, white, jack, and Scotch pine are most likely to be attacked, with white pine being subject to most serious damage. This, of course, is a matter of concern to the expanding Christmas tree industry of the state, as well as to other plantation owners.

Bagworms have an unusual feeding habit on white pine. In a few plantations, the tops of trees ranging from 7 to 14 feet high have been completely defoliated. In addition, the bark of the upper trunks has been extensively chewed — down to the sapwood — as hordes of bagworm larvae have moved downward in search of food. Such extensive damage is a serious problem to Christmas tree growers, for even minor damage may make trees unmerchantable.

The top of this white pine has been defoliated and the bark has been chewed by bagworm larvae.

After extensive bark chewing, the upper trunk dries out. Sometimes the top 4 or 5 feet of white pine trunks have been killed as the result of bark chewing and repeated top defoliation. This may cause poor trunk form in trees that are intended for use as posts, poles, or saw logs.

In the Department of Forestry, we are trying to determine the combination of environmental factors that makes large bagworm populations possible in pine plantations. Once we know this, we hope to be able to recommend ways of economically altering the environment and thus minimize this potentially serious hazard to the production of pines. — *R. G. Rennels*

FARM BUSINESS TRENDS

Farmers of the United States are vitally concerned with foreign trade — both exports and imports. They need export markets because they produce much more of many farm products than can be sold in this country. They are concerned with imports because we must buy from people in other lands so they can earn the money to pay for the farm products that we ship to them.

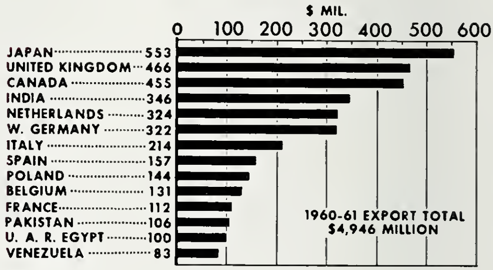
In the year ended June 30, 1961, exports of farm products were valued at $4,946 million and represented the produce from one acre of every six harvested.

Exports provided outlets for around half of our rice, wheat, and cotton, 43 percent of our tallow, 29 percent of our tobacco and barley, 25 percent of our soybeans, 20 percent of our lard, 19 percent of sorghum grains, and 15 percent of our corn. (Except for lard and tallow, these are percentages of sales by farmers.)

Japan became our biggest foreign market in 1961, displacing the United Kingdom. The U.K., Canada, India, Netherlands, and West Germany also were big buyers. All of these nations, except India, are strong cash customers. India pays cash for some products, but along with other developing countries also receives farm products under special export programs. More than 120 other countries buy smaller amounts of our farm products.

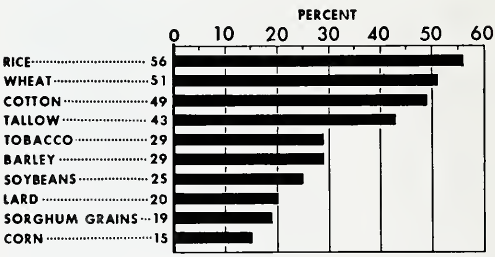
Our farm products compete in foreign markets with large amounts of products from other exporting countries. The total value of all agricultural products moving in international trade is around $31 billion a year. Most of these products are competitive with those exported from the United States. — *L. H. Simerl, Professor of Agricultural Economics*

71% OF U. S. AGRICULTURAL EXPORTS GO TO 14 MARKETS



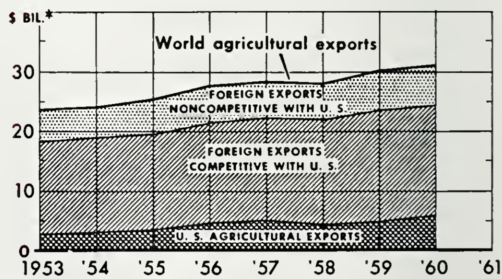
Year ending June 30, 1961.

EXPORTS PROVIDE BIG OUTLET FOR MANY U. S. FARM PRODUCTS



Exports compared with farm sales for crops and with production for lard and tallow. Data are for fiscal year 1960-61.

WORLD AGRICULTURAL TRADE ADVANCES TO RECORD IN 1960



* Quantities traded valued at average 1952-54 prices of U. S. exports or imports.

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Spring, 1962

ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

IN THIS ISSUE

The lunch program of the Child Development Laboratory has offered an opportunity to study the food preferences of nursery school children (page 12).

Volume 4, Number 2 UNIVERSITY OF ILLINOIS COLLEGE OF AGRICULTURE URBANA, ILLINOIS

ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

CONTENTS

Spring, 1962 Volume 4, Number 2

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RESEARCH IN THE DEPARTMENT OF PLANT PATHOLOGY no longer concerns itself only with the identification and control of plant diseases. Recent advances indicate that two important aspects of research in plant pathology must always be kept in perspective — the basic and the applied. These types complement each other. Without the applied research the basic studies would die of economic starvation, and without an increase in basic knowledge the applied phases would starve for lack of new information.

Through use of the new basic research tools, such as radioactive tracers, chromatography, electrophoresis, freeze drying, vacuum distillation, electron microscopy, and mutagenic chemicals, more fundamental aspects of the diseases are being investigated. Such research includes studies on host-parasite interactions, fungus physiology, genetics, and many others. The biochemistry of viruses is being investigated to a greater extent than ever before. Through the study of viruses, more is being learned of the nature of the gene, and a great impetus has been given to the search for the nature of life itself.

Disease diagnostic services are no longer limited to the commercial producers of field crops, fruits, or vegetables. With the rapid growth in urban population, requests for help on diseases of lawn and turf grasses, flowers, and backyard gardens have increased a hundredfold.

We in the Department of Plant Pathology are thus trying to fulfill our service obligation to the citizens of the state, and at the same time carry on a balanced program of research that will contribute to the progress of our science. — *W. M. Bever, Head of the Department*

Dr. Bever has held his present position since 1957. From 1949 to 1957, as an appointee of both the Agricultural Research Service, U. S. Department of Agriculture, and the College of Agriculture, he was responsible for coordinating research on loose smut of wheat in the eastern soft red winter wheat region.

New facilities for research in VETERINARY MEDICINE

D. H. FERRIS and S. K. SINHA

IN THE NEW BUILDING pictured above, research can be done on any animal disease without the usual danger of cross infection. It is the first secure isolation building on the University campus.

The official name of the building is the Veterinary Medical Research Building, but it is often referred to as the "Zoonoses Building" because it provides laboratory space for the Center for Zoonoses Research.

This Center, which was organized in September, 1960, is the only one in the world devoted entirely to research on zoonoses, or diseases transmissible between animals and man. (The Pan American Zoonoses Center, set up by the World Health Organization in Azul, Argentina, has not had research as its primary function.)

Many colleges and departments are cooperating in the Center. Among them are the College of Veterinary Medicine (which sponsored and organized the Center), the College of Agriculture, the Agricultural Experiment Station, the School of Life Sciences, the College of Medicine, the University Health Service, and the Natural History Survey.

Funds for the building were provided by the University of Illinois, the National Institutes of Health, and Mr. Max Stern, President of Hartz Mountain Products Corporation. Dr. Lyle E. Hanson of the College of Veterinary Medicine and Mr. Summerfield H. Day, Associate Architect of the University, were largely responsible for the plan and design.

Need for the building

An isolation building is necessary for many types of research. It is needed, for example, to prevent cross-contamination by such infectious diseases as hog cholera; to protect laboratory workers from such zoonoses as Q fever; and to eliminate vectors (insects and other disease-carrying agents).

Another use is the production of maximally pathogen-free (MPF) and germfree (GF) laboratory animals. Colonies of GF mice and chickens and of MPF mice are being established in cooperation with Dr. William Dolowy, Administrator of the Medical Research Laboratory of the Chicago Professional Colleges.

Some features of building

The apparent simplicity of the building conceals complexities only hinted at by the maze of pipes, conduits, and machinery in the mechanical room.

Forced air is used without recirculation. Each isolation room receives air which is dried, cooled to 60° F. in summer, and then heated to the temperature required for a particular experiment. Air pressure is lower in the isolation units than in the rest of the building. Thus, if the door of a unit is opened, air will not escape from the unit.

After filtration to remove any disease agents, the air is expelled through a stack at a speed of 2,000 feet a minute. In case the filter system should break down, this method of expulsion would cause enough dilution and weathering of disease agents that there would be little possibility of accidental exposure.

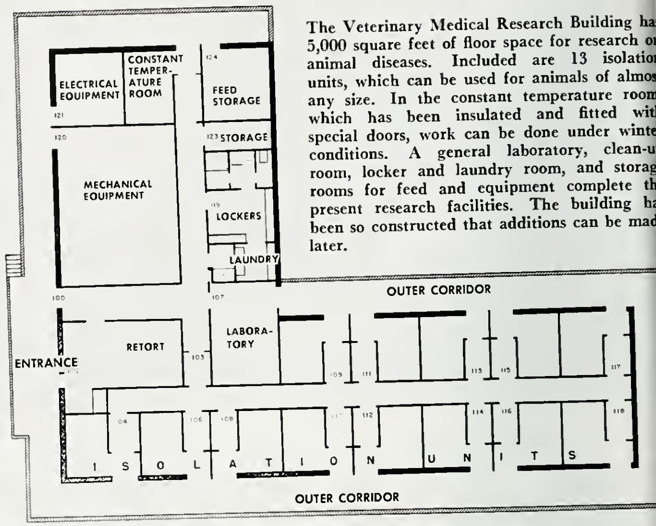
Units are decontaminated by closing all air ducts, sealing the door frames, and using steam or such fumigants as formaldehyde.

Radiant heat keeps the floors dry, so that bedding is not needed for large animals. Sewage is treated with chlorine before it enters the city sewer system. Carcasses and waste materials are put into stainless steel containers and subjected to steam under pressure in the huge retort.

Strict safety regulations, under the supervision of Dr. S. K. Sinha, Building Director, and Dr. G. T. Woods, College Safety Officer, are followed by research workers. Some of these precautions are described on page 5.

D. H. Ferris and S. K. Sinha are Associate Professors in the College of Veterinary Medicine and Senior Members of the Center for Zoonoses Research. Dr. Sinha is also Assistant Coordinator for Veterinary Medicine, International Cooperation Programs.

Dr. Sinha stands in the outer corridor. Louvers (in right part of picture) let in light and air but are strong enough to keep large animals from escaping.



The Veterinary Medical Research Building ha 5,000 square feet of floor space for research or animal diseases. Included are 13 isolatioı units, which can be used for animals of almos any size. In the constant temperature room which has been insulated and fitted witl special doors, work can be done under winte conditions. A general laboratory, clean-u room, locker and laundry room, and storag rooms for feed and equipment complete th present research facilities. The building ha been so constructed that additions can be mad later.

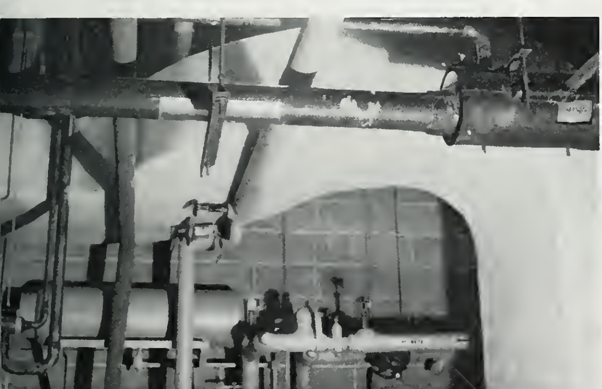
Dr. L. H. Lanier, Executive Vice President and Provost of the University, welcomes visitors to dedication of the building in September, 1961.

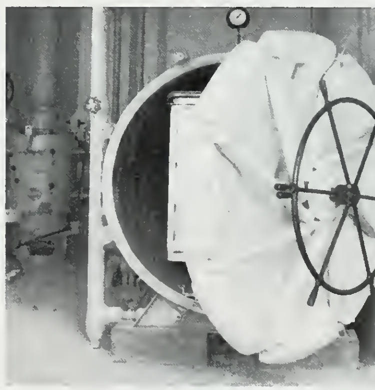
Mr. Max Stern, President of the Hartz Mountain Products Corporation, donor of two units, speaks at the dedication.

Dean C. A. Brandly, who took a very personal interest in the progress of the building, inspects it as it nears completion. The entire animal industry in Illinois will benefit from the structure, since there are no other comparable facilities in the state for observing and doing research on animals with infectious diseases.

: "main hall," showing entrances to 10 of the 13 ation units. Note hooks for outer garments, covered tches, individual temperature controls, floor drains, observation windows through which workers can ›ect animals without entering units.

Two views inside an isolation unit set up as a large animal stall. Fixtures may be replaced by those for small animals or laboratory equipment. Doorway at top right leads through a small entranceway into the main hall. The entranceway is equipped with wash basin and shower. A research worker enters the isolation area in laboratory garment and disposable paper sandals, after showering and leaving his street clothes in the locker room. He changes into work clothes in the entranceway; then, before leaving a unit, showers and leaves his work clothes behind.





Complicated equipment in the mechanical room insures safe working conditions. Filtered-air duct (with the "S" curve) is shown above.

Carcasses and other wastes are decontaminated in the steam retort shown at upper right. A can sterilizer and steam generator are in the same room.

In picture at right, Dr. L. E. Hanson (left) and Dr. Sinha demonstrate the retort to Provost Lanier and other visitors at the dedication ceremony.

The Calcium-Phosphorus Ratio in Blood

Milk fever may develop primarily because the phosphorus level in the blood serum is low in relation to the calcium level

K. A. KENDALL and K. E. HARSHBARGER

When a dairy cow is suffering from milk fever (parturient paresis) her blood serum is usually low in calcium. Consequently, it has been generally assumed that this lack is a major cause of the disease. According to research both here and elsewhere, however, the relationship of phosphorus to calcium in the blood serum may be more important than the calcium level.

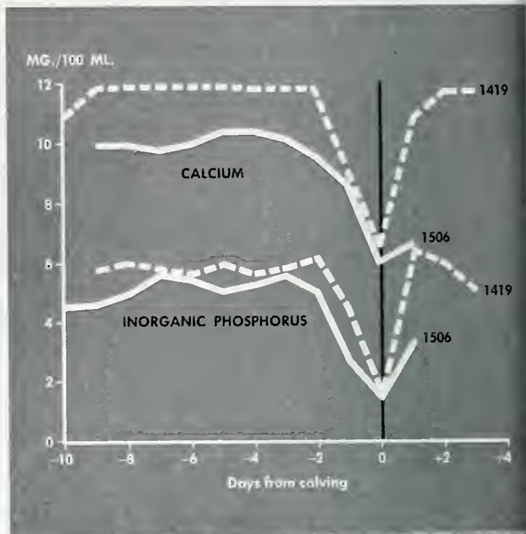
Why theory developed

Workers in Wisconsin found that the blood serum of milk fever cows, before inflation of the mammary glands, contained 3.1 to 5.2 milligrams of calcium per 100 milliliters of serum, and 0.50 to 0.62 milligram of phosphorus. Normal levels are 10 to 11 for calcium and 4 to 6 for phosphorus. The Wisconsin figures would therefore indicate a greater decline for phosphorus than for calcium.

We observed the same thing in experiments at Illinois. And workers in California found that a good way to prevent milk fever was to feed a ration low in calcium and high in phosphorus (1:3 ratio) for one month before the expected calving date.

K. E. Harshbarger, Associate Professor of Nutrition, Department of Dairy Science, was recently asked by the Department of Defense to spend about a month in Jordan, participating in a nutrition survey of armed forces and civilians there.

In addition to his teaching and research duties as Professor of Dairy Science, K. A. Kendall is overall chairman of the committee planning the new Farm and Home Science Show to be held at Urbana in September. He was also chairman of the committees for the last two Farm and Home Festivals.



Cows 1419 and 1506 did not develop milk fever even though their blood calcium levels at calving were below the average level for 12 cows that did develop milk fever. The ratio of calcium to phosphorus was 3.9:1 for cow 1419, and 3.7:1 for cow 1506. (Fig. 1)

In more recent experiments at Illinois, when cows with milk fever received intravenous injections of calcium gluconate, the immediate rise in blood calcium was accompanied by an unexpected rise in blood phosphorus. As the calcium-phosphorus ratio approached normal, the cows lost their symptoms and could rise and stand normally.

All these experiments support the hypothesis, first advanced by the Wisconsin workers, that the calcium-phosphorus ratio may be the most important factor in milk fever.

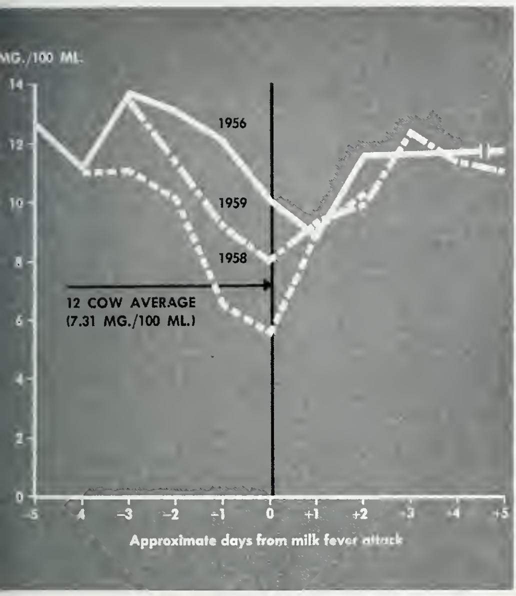
Three cows studied

Further evidence has been found in the records of three cows in the Illinois herd. These cows were bled daily for several days before and after calving, and the levels of calcium and inorganic phosphorus in the blood sera were measured. A typical ration of legume hay, pasture, silage, and concentrates was fed.

Two cows without milk fever

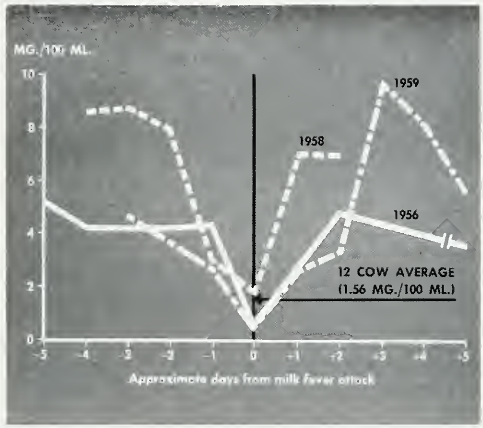
Two of the cows (1419 and 1506) did not develop milk fever even though their calcium levels at calving

Serum of Cows With Milk Fever



Blood calcium levels for cow 1332 at time of milk fever attacks in 1956, 1958, and 1959. In two of these attacks, blood calcium remained above the 12-cow average and above the levels for cows 1419 and 1506. (Fig. 2)

Cow 1332 during one of her milk fever attacks. (Fig. 3)



Levels of inorganic phosphorus in the blood serum of cow 1332. The drops in phosphorus were greatest in 1956 and 1959, when the attacks were most severe. (Fig. 4)

dropped to 6.8 and 6.1 milligrams per 100 milliliters (Fig. 1). These levels were below the average level for 12 cows in the University herd that did develop milk fever (Fig. 2).

Inorganic phosphorus levels for cows 1419 and 1506 declined to 1.7 and 1.6 milligrams per 100 milliliters. These levels were slightly above the average of 1.56 for the 12 cows with milk fever.

The ratio of calcium to phosphorus on the day of calving was 3.9:1 for cow 1419 and 3.7:1 for cow 1506. The average ratio for the 12 milk fever cases was 4.7:1.

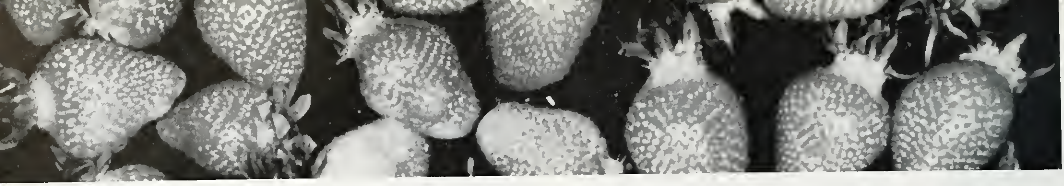
One cow with milk fever

A third cow, 1332, developed milk fever after three calvings — in 1956, 1958, and 1959 — and had to be treated with calcium gluconate. In two of these three parturitions, however, the calcium level in the blood serum remained more nearly normal than for cows 1419 and 1506. Average drop in serum calcium for all three parturitions of cow 1332 was less than 50 percent.

Inorganic phosphorus, on the other hand, declined as much as 94 percent in 1959. In 1956 and 1959 the phosphorus level of cow 1332 was well below the average for the 12 milk fever cases. In both these years, especially in 1959, the attack was severe. The maximum calcium to inorganic phosphorus ratio was 16:1 for the 1956 attack and 17:1 for the 1959 attack.

These results support the theory that milk fever develops when the phosphorus level in the blood serum is low in relation to the calcium level, rather than when just the calcium level is low.

The cooperation of Drs. Bruce Bradie and R. D. Hatch, College of Veterinary Medicine, in treating milk fever cases with calcium gluconate is gratefully acknowledged.



Strawberry varieties for Illinois Growers

C. C. ZYCH, J. W. COURTER, and J. B. MOWRY

No matter what cultural practices you use, you can't overcome the handicap of a poorly adapted strawberry variety or of "bargain plants" that are weak or diseased. For a good crop, plants should be certified free of viruses, root diseases, and nematodes, and should be suitable for local growing conditions. Good plants of the right variety are the least expensive in the long run.

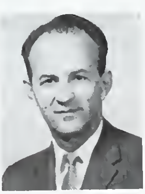
To help Illinois growers evaluate the newer varieties, the Department of Horticulture has been conducting a variety trial program since 1957. Trial plantings are made on experimental fields at Urbana, Carbondale, and Dixon Springs, and also on farmers' fields. Recommendations given here are based on results of these trials and on observations of plantings throughout the state.

Some variety characteristics are listed in the table; others are given in the following paragraphs.

Discussion of varieties

Armore is a productive late variety for home gardens and local sales. The fruit is too soft to be shipped far.

Blakemore, the standard commercial variety in southern Illinois for many years, is still widely planted. The fruit has a high pectin content and is easy to hull, so it is especially desirable for preserves. Most serious drawbacks are low yields and a rapid decrease in berry size as harvest progresses.



C. C. Zych is Assistant Professor of Pomology at Urbana. Co-author J. W. Courter is at the Dixon Springs Experiment Station; and J. B. Mowry, at the Illinois Horticultural Experiment Station, Carbondale.

Catskill is recommended for home use and local market only. The fruit is usually too soft for distant shipment.

Dixieland has the same season as Blakemore, without Blakemore's rapid loss of fruit size, and is recommended for the Blakemore area. The berry is very firm and ships well.

Earlidawn is recommended principally because it is very early, with frost-hardy flowers. On drouthy or infertile soils, plants are shy runner makers and should be set close together.

Fairfax is considered the standard variety for high dessert quality. It is recommended for home gardeners for fresh use, but not for freezing. Plants are shy runner makers and should be planted close together.

Jerseybelle, a very late variety, is recommended for home gardens because of its lateness and its fruit, which is unusually large and quite attractive, with high gloss and prominent yellow seeds. It is acceptable for fresh use but is quite poor in a frozen pack. Yields are too low for successful commercial production in Illinois.

Pocahontas, a midseason variety, is recommended for both commercial production and home use. It is very productive, and its fruit is firm enough to stand shipment. It also has good freezing quality.

Redstar is the latest variety tested at Urbana. Because of low yields, it is not recommended for commercial plantings, but it is useful in home gardens to extend the season.

Robinson is a late, large-fruited variety for commercial production in northern Illinois. It deserves a qualified recommendation because of its productivity and large, furrowed fruit. However, the fruit is too soft for distant shipment, it is only fair for fresh use, and it makes a very poor frozen pack. The soft, white-fleshed, mildly flavored berries make the variety a poor choice for the home gardener.

Sparkle, a productive, late variety rating high in dessert and freezing quality, is a desirable all-purpose variety for the home garden. The fruit is difficult to pick and in southern Illinois is too soft for shipment. In northern Illinois it is firmer and the variety is recommended for commercial production. Sparkle is resistant to the common strain of the red stele disease.

Surecrop is resistant to four strains of the red stele fungus and to Verticillium wilt. It is recommended for planting wherever red stele is a problem in Illinois. Even in non-infested soils it should be considered as a midseason variety because of its consistently high yields. Plants are very vigorous and runner freely. A spaced-plant system or narrower rows seem to be better suited for Surecrop than the conventional matted rows, which may develop very dense foliage.

Tennessee Beauty, a very productive, late variety, is a standard commercial variety in southern Illinois, and is recommended for home gardens throughout the state. The fruit tends to have a green tip until fully mature, caps easily, and when the moisture supply is low, is medium-size to small. With supplemental irrigation, high yields of marketable fruits may be expected.

Vermilion is an early variety resistant to red stele. Its attractive, high-quality fruit makes it a good home-garden variety for dessert purposes. Commercial growing is limited to production for local markets in northern Illinois.

Everbearing varieties are recommended only for home gardeners who want fresh strawberries throughout the summer and early fall. No everbearing variety tested so far can match the best spring-fruiting types in yield and quality. Spring crops are usually satisfactory, but summer and fall crops may be quite disappointing, particularly in the southern part of the state.

Disease-resistant varieties

The red stele disease and Verticillium wilt are caused by fungi which persist in the soil for many years. So far the only feasible method of controlling these diseases is to plant resistant varieties.

Of the available varieties that are resistant to red stele, Surecrop, Vermilion, and Sparkle seem best adapted to Illinois conditions. Vermilion and Sparkle are best suited for commercial production in the northern part of the state, but are resistant to only the common race of the fungus. At least one other race has been found in Illinois, so Surecrop, with its multiple resistance and statewide adaptability, provides the maximum insurance.

Midway, a midseason variety that became available to growers in 1961, is resistant to the common race of red stele. It is recommended for trial where red stele is a problem.

Varieties differ widely in susceptibility to Verticillium wilt, which causes "summer dying" of plants. In New Jersey tests (Varney et al.) Vermilion, Catskill, Surecrop, Tennessee Beauty, and Gem were among the most resistant varieties. Earlidawn, Dixieland, Redstar, Jerseybelle, Pocahontas, Armore, and Sparkle were highly susceptible.

No variety should be planted in land which has been in tomatoes, Irish potatoes, eggplants, or peppers within the past three years. Verticillium wilt has been especially serious when strawberries have followed any of these susceptible crops.

Leaf spot, leaf blight, and leaf scorch are foliar diseases caused by fungi. Severe infections by one or more of these diseases have been observed on all the varieties listed in the table except Surecrop and Vermilion. Although these diseases are quite difficult to control when climatic conditions favor their development, fungicides will help to reduce infection. Further information on the control of these and other pests of strawberries may be obtained from the Department of Plant Pathology, University of Illinois.

Varieties for epicures

Fairfax, Fairpeake, Midland, Dorsett, and Redglow are recommended for their flavor, texture, and aroma. Red Rich, an everbearing variety, might be added, although its performance is erratic. These varieties are for the home gardener who does not judge strawberries by size, color, and yield alone but who likes to treat his palate with as much discrimination as a music lover treats his ear. Try them if you value quality over quantity.

Varieties with too many names

A different name doesn't always mean a different variety. Each numbered group below includes "varieties" that cannot be told apart.

(1) Armore, Red Cluster, Red June
(2) Dunlap, Parish
(3) Fairfax, Grandview, Cummerbund, Black, Black Hornet
(4) Gem, Superfection, Brilliant
(5) Howard 17, Premier, Polar Queen, Golden Bell
(6) Midland, Crimson Flash, Adonis
(7) Robinson, Scarlet Beauty, Kardinal King
(8) Sparkle, Paymaster

Varieties for the future

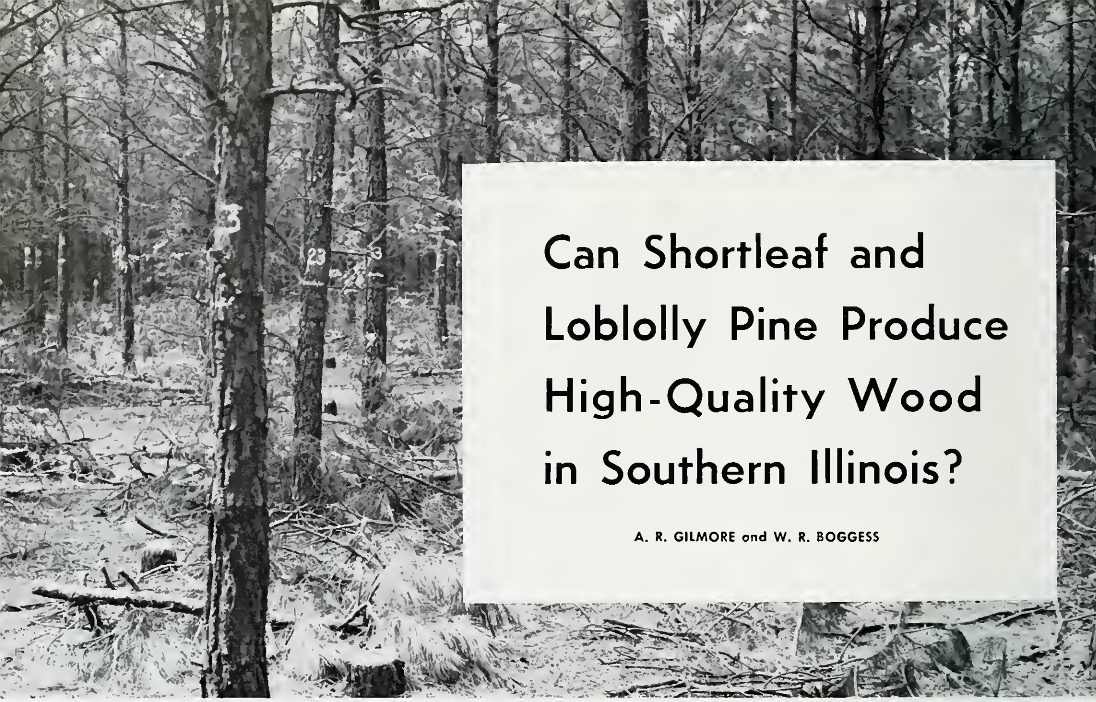
The perfect strawberry has yet to be found. If at all possible, growers should continue to try the new varieties until a productive variety is developed that is as resistant to red stele as Surecrop, as firm as Tennessee Shipper, as fine-flavored as Suwannee, and as uniform in shape as Albritton.

Some Characteristics of Strawberry Varieties Recommended for Illinois

Variety	Season	Fruit size	Firmness	Dessert quality	Freezing quality[1]	Use[2]
SPRING-FRUITING VARIETIES						
Armore	Late midseason	Large	Medium	Good	Poor	S-CH
Blakemore	Early	Small	Firm	Fair	Good	S-CH
Catskill	Midseason	Large	Soft	Fair	Poor	N-CH
Dixieland	Early	Large	Very firm	Fair	Good	S-CH
Earlidawn	Very early	Medium	Medium	Fair	Very good	SN-CH
Fairfax	Midseason	Medium	Medium	Excellent	Fair	SN-H
Jerseybelle	Very late	Very large	Medium	Fair	Fair	SN-H
Pocahontas	Midseason	Large	Medium	Good	Very good	SN-CH
Redstar	Very late	Medium	Medium	Fair	Poor	SN-H
Robinson	Late midseason	Large	Soft	Fair	Poor	N-C
Sparkle	Late	Medium	Soft	Very good	Good	N-CH, S-H
Surecrop	Midseason	Medium	Medium	Good	Good	SN-CH
Tennessee Beauty	Late	Medium	Firm	Good	Very good	S-CH, N-H
Vermilion	Early	Large	Soft	Very good	Good	S-H, N-CH
EVERBEARING VARIETIES						
Gem[3]	....	Small	Soft	Fair	....	SN-H
Ogallala	....	Small	Soft	Fair	....	N-H
Ozark Beauty	....	Medium	Firm	Good	....	S-H
Twentieth Century	....	Medium	Medium	Fair	....	N-H
Streamliner	....	Medium	Medium	Fair	....	SN-H

[1] There has been no opportunity to observe freezing quality of everbearing varieties.
[2] S = southern Illinois; N = northern Illinois; C = commercial planting; H = home garden.
[3] Indistinguishable from Brilliant and Superfection.

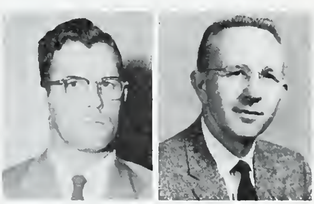
For results of recent tests on freezing strawberries, see page 19.



Can Shortleaf and Loblolly Pine Produce High-Quality Wood in Southern Illinois?

A. R. GILMORE and W. R. BOGGESS

LARGE ACREAGES of land in southern Illinois have had to be abandoned for agricultural purposes. Before this land was cleared, it supported excellent stands of mixed hardwood timber. Poor farming practices, however, greatly accelerated erosion. Now many sites have been reduced to the point where the valuable native hardwood species cannot be grown successfully. Only pine species with relatively low site requirements are suitable.



A. R. Gilmore (left), Assistant Professor of Forestry, is stationed at the Dixon Springs Experiment Station near Robbs. Before joining the University staff in 1958, he taught at the University of Florida and Alabama Polytechnic Institute, and worked as a forester in industry. W. R. Boggess (right), Professor of Forestry, was formerly at Dixon Springs, but is now teaching and conducting research on the Urbana campus.

Two such species, shortleaf and loblolly, have been planted extensively in the area. These pines are native to the southern states, and southern Illinois is at the limit of or north of their natural ranges.

Quantity and quality measured

How does pine wood grown in southern Illinois compare with that produced in the southern states? This question is frequently asked by potential users. They are interested not only in the quality of the wood, but also in the quantity that can be grown on a given acre. To determine these factors, we have measured a large number of shortleaf and loblolly pine plantations in 12 southern Illinois counties.

Determining quantity was relatively simple — this only required measurement of the diameters and heights of trees on plots of known area. Wood quality, however, was not so easily determined. We chose specific gravity as an index of quality, since it is related to pulp yields, strength, paintability, and working characteristics. Specific gravity of wood is the weight of a given volume as related to the weight of an equal volume of water.

Since it was impractical to cut a large number of trees from each plantation and haul them to the laboratory, we had to devise a simple method of estimating tree specific gravity from a small sample of wood. Increment cores, taken at heights of 1 foot and 4½ feet above the ground, proved to be the answer. These cores are slightly smaller in diameter than an ordinary "soda straw" and are taken along a tree radius with an increment borer — a tool widely used by foresters (Figs. 1 and 2).

Specific gravity was determined for nearly 100 entire trees harvested

Comparison of Dry Weights of Wood From Illinois and Mississippi

Species and location	Lb. per cu. ft.	Lb. per cord	Difference per cord
Shortleaf pine			
Illinois......	27.2	2,448	....
Mississippi...	29.5	2,655	+ 207
Loblolly pine			
Illinois......	26.0	2,340	....
Mississippi...	28.4	2,556	+ 216

throughout the area. The results were very near the figures obtained by multiplying the specific gravity of cores taken at the two heights and using the resulting products in a mathematical equation to estimate tree specific gravity. These estimates varied no more than 4 percent from the actual values.

Illinois wood lighter

When our results were compared with those from a similar study in Mississippi, we found that Illinois-grown wood was lighter than that produced in Mississippi (see table). This agrees with observations of other workers that the specific gravity of these two species decreases as one goes northward or westward from Georgia.

What do these dry weight differences mean? If we assume that pine growth will produce a cord of wood per acre each year, then an acre of 20-year-old trees in Illinois will produce 2⅛ tons less of dry wood than a comparable acre in Mississippi. This would amount to a considerable quantity of pulp for a mill using large amounts of wood.

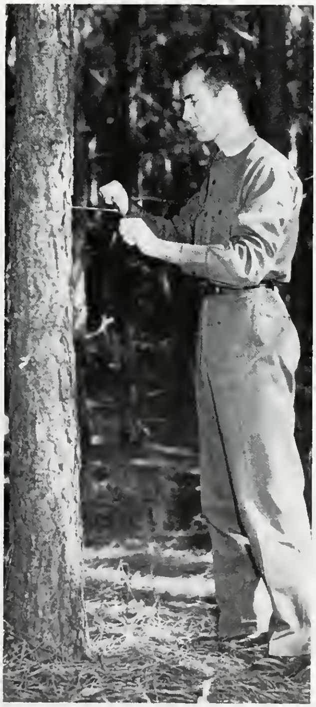
The lighter weight of Illinois-grown southern pine does not at all rule out its use for pulp. However, it is a fact that should be recognized by both the producer and the user of pulpwood. Since there is a general trend toward buying pulpwood on a weight rather than a volume basis, the weight aspect becomes more and more important to the producer.

More plantings justified

Average specific gravity of shortleaf pine wood (0.435) was higher than that of loblolly pine (0.416) in the southern Illinois plantations. The superior growth of loblolly, however, more than compensates for its lighter weight. The growth rate of both species, in pulpwood-size stands, compared favorably with that reported from states to the south.

Extensive planting of loblolly and shortleaf pine on idle lands in southern Illinois should be encouraged. This will help attract the pulp and paper industry to southern Illinois and thus aid the economy both here and in neighboring states.

Increment borer (A), extractor for removing the core after the borer has been drilled into the tree (B), and cores from young pine trees (C). A pair of light and dark bands on the cores represents one year's growth. Light bands are spring wood; the darker ones, summer wood. Specific gravity is related to the proportion of spring to summer wood. In pines, the more summer wood, the greater the specific gravity. (Fig. 1)



Forester taking an increment core at the 4½-foot height level. (Fig. 2)

Acceptance of DIFFERENT FOODS by NURSERY SCHOOL CHILDREN

RITA H. McGREER and FRANCES O. VAN DUYNE

The Child Development Laboratory makes noon meals available to nursery school children four days a week.

Teaching children to eat and enjoy a wide variety of nutritious foods is a matter of concern to parents, child development specialists, and nutritionists.

Since 1956, the Child Development Laboratory, Department of Home Economics, has been making noon meals available to nursery school children four days a week. Main objectives of this program are to help the children form good eating habits and to give University students an opportunity to observe this phase of child development. Research which might contribute to the first objective is encouraged.

An opportunity was thus provided to investigate this question: Will varying the method of preparing a frequently refused food increase children's acceptance of that food?

The study was conducted in the first semester of the 1958-59 school year. During the preceding summer, it was necessary to select the foods to be studied, standardize preparation methods, plan for including variations of the foods in the menus, and decide how to objectively measure the children's acceptance of the foods.

How foods were chosen

Food history forms are filled out by the parents of every child in the lunch program. Between September, 1956, and May, 1958, 43 histories were obtained. Data from these were compiled in terms of numbers of children liking, accepting, refusing, or never being served a food.

Certain vegetables, liver, fresh fish, and cottage cheese were checked most often as being refused or never served. Of these, 16 were chosen for the study: asparagus, beets, broccoli, Brussels sprouts, cabbage, cauliflower, Lima beans, peas, spinach, squash, sweet potatoes, raw tomatoes, cooked tomatoes, cottage cheese, frozen halibut, and liver. All are commonly consumed foods and except for beets are nutritionally valuable.

Preparation methods and menus

Three methods of preparation were chosen for each test food. During the summer, preliminary work was done on the recipes to obtain the most acceptable products.

Sixteen menus were planned, each including one of the 16 less-liked foods. Most menus included meat, eggs, or other high-protein food; a starchy vegetable or breadstuff; a cooked vegetable; a raw vegetable or fruit; a dessert; and milk. By repeating the same 16 menus three times during the semester, each variation of a test food could be served with the same accompanying foods.

This paper is based on a Master's thesis by Rita H. McGreer, former Assistant in Home Economics. The thesis was written under the direction of Frances O. Van Duyne, Professor of Foods.

How acceptability was measured

It was decided to measure acceptability of the test foods in two ways: by recording how many children liked, accepted, or refused a food; and by noting the order in which the children finished the items served at a meal.

If a child ate one standard serving, the teacher would record that the child "accepted" the food. If two or more servings were eaten, the food would be checked as "liked," and if the first serving was not completely eaten, the food would be considered "refused." The teacher would also note when a child completed the first serving of a test food and what other foods (out of a total of four to six) were left.

Food preferences

Percentages of children liking, accepting, and refusing various foods were calculated from 63 food histories obtained before the children were enrolled in the lunch program. These histories included the 43 already mentioned, plus the histories of 20 three-year-olds entering nursery school in the fall of 1958.

The children liked and accepted meats, fruits, dairy products, breads, and cereals more than vegetables. Bacon, beef, ham, poultry, and wieners were the most preferred meats (percentages of children liking them ranged from 69 to 85), while

liver (liked by 32 percent) and fish (mean liking for different types 31 percent) were less popular. Apples, bananas, and seedless grapes were the best liked fruits.

Among the foods in the bread and cereal group, white bread, dry cereals, soda and graham crackers, pancakes, and waffles were liked by about 75 percent of the children. Whole wheat bread, macaroni, rice, and spaghetti were less popular but still widely accepted (mean liking 40 percent, accepting 43 percent). The children preferred plain milk (74 percent liking) to chocolate milk (61 percent liking). Other dairy products were generally well liked; cottage cheese (44 percent liking) was the lowest in this group.

Corn on the cob, whole kernel corn, and raw carrots were liked by 82, 59, and 61 percent of the children, respectively. White potatoes were generally popular, but were preferred as chips (liked by 86 percent) or French fries (liked by 79 percent). Most vegetables, however, were less well liked. Of those chosen for study, the range in liking was from 35 percent for peas to 6 percent for cooked cabbage.

Acceptance of test foods

From 10 to 28 children participated in the lunch program during the experimental period. They were all normal, healthy children ranging in age from three to five years. The percentages of children who liked, accepted, and refused the three variations of 12 cooked vegetables, and the mean order of finishing them are given in the table.

Acceptance of Cooked Vegetables Prepared by Three Methods

Vegetables	Method of preparation[1]	Percentage of children: Liking	Accepting	Refusing	Mean order of finishing[2]
Asparagus	Buttered	46	15	39	2.8
	Casserole	20	45	35	3.2
	With browned crumbs	25	56	19	3.3
Beets	With orange sauce	10	40	50	2.4
	Buttered	24	43	33	2.8
	Harvard	18	53	29	3.1
Broccoli	Soufflé	20	30	50	2.8
	Scalloped	5	63	32	3.3
	Buttered	50	28	22	2.7
Brussels sprouts	With browned crumbs	31	38	31	2.2
	Scalloped	24	52	24	3.5
	Buttered	33	40	27	2.3
Cabbage	Buttered	28	36	36	2.4
	With bacon	21	63	16	2.7
	Scalloped	7	52	41	2.9
Cauliflower	Buttered	40	10	50	4.0
	With browned crumbs	33	38	29	4.0
	With cheese sauce	35	35	30	4.8
Lima beans	Casserole	36	43	21	3.4
	Buttered	59	35	6	3.1
	With bacon	39	46	15	3.3
Peas	With cheese sauce	14	57	29	2.9
	Buttered	33	48	19	2.8
	Creamed	29	43	28	2.8
Spinach	Buttered	50	30	20	2.3
	Casserole	17	72	11	3.1
	Loaf	44	28	28	2.9
Squash	Buttered and baked	14	50	36	2.6
	Mashed	15	45	40	2.8
	Casserole with pineapple	40	33	27	2.9
Sweet potatoes	Mashed	22	21	57	2.5
	Croquettes	24	41	35	3.2
	Baked	25	43	32	2.6
Tomatoes	Stewed	43	21	36	2.2
	Baked with corn	56	44	0	2.7
	Baked with cheese	41	41	18	2.6

[1] Listed in order according to the cycle in which each method was used.
[2] Only the variations of one food should be compared, since the number of items in the meals differed.

Results confirmed previous reports that nursery school children prefer simply prepared foods. Boiling and buttering was the best liked method for nine of the 12 cooked vegetables.

However, six of these nine vegetables were *accepted* more frequently, and refused less frequently, when prepared by one or both of the other two methods than when buttered. This suggests that the characteristics of foods which children object to may be altered or minimized by changes in the method of serving.

Halibut was liked by 50 percent of the children when it was broiled or oven-fried, but was liked by only 25 percent when it was cooked au gratin. Liver was not well liked whether baked, served with gravy, or made into patties. Percentages of children liking the three methods were 15, 22, and 6 respectively.

Statistical analysis of the data on liking, accepting, and refusing indicated that the preference for buttered broccoli over scalloped broccoli and broccoli soufflé was significant at the 5-percent level. Other variations for which there was a significant preference were squash and pineapple casserole over baked squash; peeled tomato wedges over tomato sandwiches; cottage cheese and pineapple salad over jellied salad; and buttered over scalloped cabbage.

Analysis of the figures for order of finishing showed that the preference for buttered spinach over spinach loaf was significant at the 5-percent level, as was the preference for buttered Lima beans over Lima beans and bacon.

It would be interesting to repeat this study with a larger group of children to see if these results were confirmed or if more significant differences in regard to liking for a certain method of preparation would be obtained.

EXTENSION REVIEWS PROGRAM NEEDS

J. B. CLAAR

DURING THE PAST YEAR the Cooperative Extension Service in Illinois has been studying the educational needs that it can and should meet in the years ahead. Scope and emphasis of the program, people to be reached, and methods to be used have all been under scrutiny.

The study was occasioned by the rapidly changing needs of society and the increasing demands on the Extension Service.

Four stages of study

The study has had the following stages:

The Card report, which was developed by a committee appointed by Dean L. B. Howard and chaired by Dr. L. E. Card, Professor Emeritus of Animal Science. This committee tried to identify the problems that would most affect Cooperative Extension in the future.

A seminar in the fall of 1960. At this seminar, outstanding representatives of each group that Extension serves were asked to identify program areas which they felt should be emphasized.

A period of analysis by the Extension staff. Groups of specialists representing different subject matter areas studied the needs and objectives which should guide Extension activity. County councils and county staffs studied the same problems, and several pilot programs were carried out successfully.

An administrative conference in the fall of 1961 to study trends in adult education and the implications for Extension methods and staffing.

The report of the administrative conference is, in a large sense, the culmination of this effort. Several significant points were also developed in the reports of the various work groups. Some of these points are discussed briefly in the following paragraphs.

Basic objective and clientele

The basic objective of Extension is, through educational activities, to help people solve their problems in a manner both socially desirable and personally satisfying, and to grow in their knowledge and competence as individuals.

Extension's clientele consists of people who want applicable, useful information on subjects related to agriculture and home economics. This clientele includes not only farmers and homemakers, but also people in agribusiness and other groups. The youth of Illinois are a special clientele group, who are reached through 4-H Club work.

Planning begins in counties

In Illinois the county Agricultural and Home Economics Extension Councils formulate and develop their county Extension programs with the guidance of the county and state Extension staff. The idea of the counties being sovereign in this regard is a central one in Cooperative Extension work and merits being continued.

The local Extension advisers must also continue to be teachers, organizers, and listeners, and know how to find the solutions to problems. They should concentrate their efforts on a well-planned and well-organized program to do an adequate job.

Responsibilities of state staff

The state Extension staff has the responsibility of providing leadership in statewide programming and informing the county staff about program opportunities.

Other functions of the state staff are to counsel field staff, develop inter-departmental and field coordination; act as liaison agents with industry and research groups; prepare publications for general distribution; develop teaching materials for local leaders; and serve as leaders in the use of sound educational methods.

Three levels of participation

Extension works with clientele groups in different ways, among which might be found three levels of participation:

A. The Extension Service initiates and conducts an active educational program for the group. Clientele includes rural families, agribusiness, and sometimes urban families. Extension is especially dedicated to developing an effective program with farm families.

B. Extension works cooperatively with a group, both to help them directly and to reach a primary audience through the group. Agribusiness, government agencies, professional groups, and farm commodity and related organizations are among such groups.

C. When requested, Extension gives assistance to government agencies, civic groups, and nonagricultural agencies.

Extension as adult education

Extension teaching is adult education, but it is more than adult education in the usual sense of the term. It is not only academic education; it is education for action.

The many other organizations now offering adult education affect Extension. For one thing, people are demanding greater excellence in subject matter and educational techniques. For another, the various educational programs in the

counties need to be coordinated. The advisers and councils could well study how educational groups could work together on common problems and how this work could be related to the Extension program. Extension should both intelligently carry forward programs that are uniquely Extension in light of what others are doing, and help the community use all available resources to solve its problems.

Greater specialization and depth

It must be recognized that many groups served by Extension are becoming more specialized in the production of certain commodities. These specializations cross departmental lines, calling for interdepartmental programs and coordination of informational materials.

Some subject matter areas need to be developed with greater depth. Such programs would benefit not only farmers and homemakers, but also people in marketing and in industries providing agricultural and homemaking services. In working with these clienteles, Extension must continue to use a spectrum of methods. However, methods should be carefully analyzed and the proper ones selected for each clientele group.

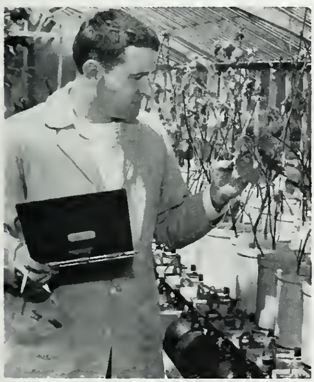
Forthcoming statement

A current statement of philosophy and purpose is now being developed to incorporate these and other ideas. This statement should be especially timely in 1962 since the Land Grant colleges and the U. S. Department of Agriculture both celebrate their centennial year. As Extension employees throughout the state take part in centennial activities, the statement will further the understanding of these programs of the future.

J. B. Cloor is Associate Director of the Cooperative Extension Service in Agriculture and Home Economics.

A Serious Shortage of Agriculture Graduates

C. D. SMITH



Chemistry and the study of plant diseases are two important areas for agriculture students.

MORE STUDENTS are enrolled in our American colleges and universities today than ever before in our history. Yet the percentage who are preparing for careers in agriculture is dropping every year. In 1940, 12.3 percent of the students enrolled in 59 Land-Grant colleges were in agriculture. In 1960, agriculture students made up only 6.8 percent of the total enrolment.

Are the opportunities in agriculture being sold short to the youth of America? When parents and counselors urge the better students to consider careers in science, are they overlooking the fact that there is science in agriculture and that agriculture is science?

Probably no other segment of our economy encompasses a broader foundation of sciences than does agriculture. Bacteriology, botany, chemistry, entomology, geology, geography, mathematics, physics, physiology, and zoology are all important and basic areas of study for agriculture students. Economics, finance, history, political science, psychology, and sociology are examples of social sciences used by agriculture graduates.

Right now, graduates are needed but not available to fill positions in Illinois as teachers of vocational agriculture, farm advisers and assistants, soil conservation specialists, and workers in practically all areas of agricultural research. If men with the proper college training in agriculture and business were available, 50 percent more than the number presently graduating would be hired by the many agricultural industries in Illinois.

Starting salaries for the 1961 University of Illinois College of Agriculture graduates averaged \$5,200 a year. According to a recent study of over 2,500 graduates, their average income was \$9,225 in 1960. Highest salaries were reported by those employed in the agricultural business and industries — with 850 graduates averaging \$11,500 a year.

Parents, teachers, and counselors can help to bring these opportunities to the attention of high school students. The College of Agriculture will supply brochures upon request which explain the many career opportunities in greater detail.

C. D. Smith is Assistant Dean of the College of Agriculture.

RESEARCH IN BRIEF

Respiratory Systems of Fungi Studied to Learn How They Infect Plants

A knowledge of the metabolism of plant pathogens is important in understanding how they infect plants. A parasite's utilization of nutrients may also be a factor in determining the relative susceptibility or resistance of the host plant. One aspect of this problem which the Department of Plant Pathology is investigating is the mechanism by which fungi degrade carbon compounds to give energy for their growth.

When a cell oxidizes a nutrient such as glucose, it does so in a series of discreet steps. As a result, the energy obtained from the oxidation is available to the cell in a useful form. In fungi, as in many other organisms, the last part of this series involves what is termed the "electron transport system." Details of this system vary with different organisms, but in general it contains four major units. These components are shown below, with arrows indicating the successive stages in the oxidation of the carbon compounds: Carbon compounds → (1) pyridine nucleotides → (2) flavoprotein (3) quinone → (4) cytochromes → oxygen.

The various parts of the electron transport system appear to be grouped together within the cell in packages called mitochondria. The function of this system is to release small amounts of energy at a time. This seems to be nature's way of releasing energy in a harmless form. If all the energy of the carbon compounds were released in one step, the cell no doubt would be injured.

Before we can study the various components of this system, we have to break the walls of the fungal cells. This is done by grinding with sand, by ultrasonic vibration, or by forcing the cells through a microscopic hole. Even these broken cells will carry out the chain of reactions and consume oxygen if one has been careful not to inactivate the components.

Extracts from the broken cells of ten species of fungi have been examined for the presence of an active electron transport system. Although the systems of the various species differed in the quantity and sometimes the quality of components, they were in general very similar. Furthermore, they greatly resembled the terminal oxidation systems of the cow, rat, pigeon, and other animals. Thus fungi are good experimental tools for studying some problems of oxidation in higher animals, including man. — *Paul D. Shaw*

Corn Synthetics Used to Develop Inbred Lines Resistant to Disease

Corn diseases, especially the leaf blights and stalk rots, continue to be of major importance in Illinois. These diseases reduce profits per acre by lowering yields and increasing production costs.

The use of corn hybrids, produced by crossing disease-resistant inbred lines, is the most feasible way of controlling most corn diseases. Inbred lines are developed by plant-breeding procedures which involve selfing and selection. Most of the inbred lines presently used in hybrid production were developed from open-pollinated varieties formerly grown in the corn belt. A few originated from hybrids produced by crossing previously developed inbred lines. In some cases, improved selections of the older lines were made.

Since the open-pollinated varieties and the hybrids developed from them do not contain all the desirable factors required to develop superior disease-resistant inbred lines, new "parental" source material is needed. Synthetic varieties may answer this need.

Synthetic varieties, more commonly known as synthetics, are produced by intercrossing a known complement of corn inbred lines, hybrids, or varieties. These synthetics are genetically more variable than conventional hybrids and are maintained and increased by open pollination in isolation. In many respects they resemble superior open-pollinated varieties but they are not intended as replacements for hybrids in corn production.

Twelve corn synthetics have been produced in the Department of Plant Pathology. All have a high degree of disease resistance. Other qualities such as early maturity, standability, yield, and adaptability are included in their makeup.

Large populations of the synthetics were grown in disease nurseries where they were exposed to artificial epiphytotics or outbreaks of leaf blight, stalk rot, and other diseases. The best plants were then self-pollinated. At harvest, a small proportion of the most disease-resistant and agronomically desirable plants were saved. In addition, selected plants in each synthetic were intercrossed to produce improved versions of each population.

Progeny tests of the inbred selections have shown that selection for disease resistance was effective. Hybrids involving the most promising selections for disease resistance were produced for yield and other tests in cooperation with the Department of Agronomy. Some of the selections may result in superior inbred lines. — *A. L. Hooker*

Why Farmers Pay the Cost of Dealer Credit

Farmers continue to use dealer credit even though it is often costly. Are there circumstances where this practice is economical?

Station Bulletin 671 reports findings of a survey among banks and

production credit associations to determine the loan limits they use when they finance purchase of assets by a typical beginning farmer or one expanding his size of business. Extending the research, we are now estimating effects of these loan limits on farm income and organization when debt obligations and farm expenses must be met at a particular time during the year.

If operating expenses have to be met in the quarter of the year when they occur, none of the farm plans considered could be operational at the lowest loan limits found in the survey. The same is true where lenders distinguish sharply, in terms of loan limits, among assets to be financed. By deferring payment of operating expenses to the end of the year these same farm plans become feasible under all lender limits. Income also is increased under these circumstances.

These results are important in suggesting why farmers may be willing to pay high costs for dealer loans to secure more liberal terms in maturity dates. — *C. B. Baker and G. D. Irwin*

Microbes Studied in an Artificial Rumen

A new apparatus designed in the Department of Dairy Science is advancing our knowledge of what happens in the rumen or forestomach.

Here is shown the entire artificial rumen apparatus, with six fermentation vessels, liquid collectors, gas collectors, and saliva-water reservoirs. The fermentation vessels are in the constant temperature water bath. The saliva-water reservoirs are on a rack above and to the rear of the water bath. Examining the apparatus is William Rufener, a graduate student who worked on the project.

This apparatus permits continuous cultivation of the entire microbial population of the rumen, including bacteria and protozoa, outside the animal. It was designed on the premise that one could maintain and grow the microbial population of the rumen in an artificial environment, if this environment duplicated as closely as possible that of the rumen in the live animal.

The microorganisms are maintained in a fermentation chamber which is initially filled with 400 milliliters of rumen fluid taken from a fistulated animal. Feed materials composed of normal roughages and concentrates are fed into the chamber. Flowing continuously through the chamber is a solution representing the saliva and water which normally flow into the rumen. Outflow from the chamber represents the outflow of rumen fluid to the lower part of the digestive tract in the intact animal. The outflow is collected at low temperatures to stop any further fermentation of the substrates. Ion exchange resins are included in the fermentation vessel to prevent the accumulation of large amounts of acids. A collection chamber for measuring gas production is connected to the apparatus.

Feed materials introduced into the vessel ferment just as they do in the live animal. The products of this fermentation (volatile fatty acids including acetic, butyric, and propionic; and the gases methane and carbon dioxide) occur in essentially the same amounts and proportions as in the live animal.

The normal bacterial and protozoan populations are stable in this artificial system. In fact, we have maintained a continuously growing population of rumen microorganisms for at least 10 days.

We are thus able to study the interrelated activities of this complex microbial population and the way in which these microorganisms digest feed. — *M. J. Wolin and W. O. Nelson*

A New Disease May Cause Death Losses of Baby Pigs

Death losses of baby pigs have for years been one of the most important problems of swine raisers. Many diseases of young pigs have been investigated, but each year a large percentage of the baby pigs die without the cause of death being determined or satisfactorily explained.

New viral diseases of the central nervous system (brain and spinal cord) have been recognized in Europe within the last few years and in Canada even more recently. This has suggested that similar diseases in the United States may account for some of the baby pig losses. Such diseases could be mistaken at times for hog cholera, since cholera often involves the brain, resulting in a marked encephalitis or brain damage.

Within the last year, as disease outbreaks causing death of baby pigs have been investigated, the incidence of encephalitis has been found to be higher than formerly recognized. In two outbreaks an encephalitic syndrome not previously described in the United States was recognized. Only the younger pigs were affected. Symptoms included vomiting, complete loss of appetite, incoordination, and extreme depression, but no fever.

The disease was reproduced experimentally, using brain tissue from the naturally infected pigs. Symptoms were the same as described

above. The microscopic lesions in the brain and spinal cord were those of an acute encephalomyelitis such as is produced by viruses.

These preliminary studies suggest that this might be a new disease in Illinois swine and that it may be the same as that recently described in Canada. Additional studies to isolate, identify, and cultivate the causative agent are now necessary. The natural route of infection, the mode of transfer in the swine population, and the occurrence and significance of the disease must also be investigated. — *T. E. Fritz*

Social Dominance in Gilts

Swine can be expected to establish a definite order of social dominance if they don't have enough feeder space. This was brought out in three recent experiments with 36 pregnant gilts.

In the first experiment, feeder space was more than adequate, and there was no evidence of a dominance order. Position of pen mates at the feeding space did not follow a regular pattern.

In the second experiment, however, in which feeder space was inadequate, the gilts soon established a dominance order by fighting and biting. This dominance order was determined by ranking individuals according to the number of pen mates bitten by each. In a group of seven gilts, one gilt completely dominated all others in the pen, while another showed no evidence of aggressiveness (biting). The other five clearly arranged themselves in an order between the two extremes.

A third experiment was conducted with four gilts from Experiment 2 and three strange gilts. Their behavior confirmed the existence of a dominance order. In addition, individual bouts between two animals occurred when they were put into a pen with one feeder space. The observations of the bouts confirmed the rank order previously indicated by observations of the entire group. — *O. G. Rasmussen, E. M. Banks, T. H. Terry, and D. E. Becker*

Carbonated Semen Extenders Prove Highly Successful

Researchers in the Department of Dairy Science found in 1957 that adding carbon dioxide to properly buffered extenders for bull semen greatly prolonged sperm survival even when the samples were not refrigerated. Tests by breeding associations in the state showed that semen stored at room temperature usually retained high fertility for nearly a week. However, semen from some bulls kept much better than semen from others. Much of this difficulty was overcome by utilizing the protection of refrigerator temperatures along with the anesthetizing effects of carbon dioxide.

Since the early trials with this diluent, which was named the Illini Variable Temperature (IVT) extender, a number of modifications and improvements have been made. The University of Illinois Foundation has patented the process and the extender is now available commercially for either the small or large breeder. It has been rather widely accepted, and excellent fertility results have been obtained in several states (Arkansas, New York, Tennessee), and in several European countries (Austria, Germany, Norway, Poland), where use of frozen semen has been too costly for full adaptation.

The Department of Dairy Science is continuing efforts to improve and utilize this new principle of semen preservation for the betterment of artificial insemination practices. — *N. L. VanDemark*

Dr. VanDemark holds sealed ampules in which carbonated semen is stored. Tight sealing prevents loss of carbon dioxide.

Using Liquid Hog Manure on Cropland May Cost More Than the Manure Is Worth

When hogs are produced in confinement, handling manure presents special problems. Early users of the confinement system put bedding in their buildings and handled manure with tractor equipment. In later units, manure could be handled as a liquid. Cleaning was done by hand, and the manure-handling job, including hauling and spreading, accounted for three-fourths of the labor needed to finish the hogs.

Many farmers are still storing, hauling, and spreading liquid manure. But others have found that the value of the fertility constituents does not pay for handling costs. Instead they have constructed lagoons for disposing of the manure inexpensively without attempting to recover its fertility value.

Based on 1960 fertilizer prices, the nitrogen, phosphorus, and potassium excreted by one hog while growing from weaning to market weight is worth about $1.62. A high proportion of this value can be retained if the manure is stored under airtight conditions, then plowed under immediately after being spread on the land. But ideal conditions are not even closely approached on the typical midwestern hog farm. Nutrient losses, especially of nitrogen, begin on the feeding floor and continue while the manure is in open storage and lying on the fields. Much potential value is wasted when manure must be spread on low-value crops or waste land. The typical producer will probably lose half to three-fourths of the fertility value in hog manure handled as a liquid.

Typical facilities for storing and spreading liquid manure include a

concrete storage tank holding 25 to 30 gallons per hog, an electrically driven auger to pump the manure from storage, and a tractor-drawn applicator tank holding 500 to 1,000 gallons. Cost of new tanks and equipment ranges from about $2 per market hog for a 2,500-hog setup to slightly more than $6 for a 250-head operation.

Weekly hauling is usually necessary. Annual costs for storing, pumping, hauling, and spreading range from $0.62 a hog for a producer with 2,500 hogs a year, to $1.28 for a producer with 250 hogs.

If a producer can save half the original value of the manure, he can cover the extra costs of handling, including wages for his own time. — *R. N. Van Arsdall*

Frozen Sliced Strawberries Evaluated by Taste Panel

Any kind of strawberry can be frozen into an edible product. Varieties differ widely, however, in suitability for freezing, and it is certainly desirable to use the better ones if possible. A few multiple-purpose varieties are good for freezing and preserves as well as for fresh use, but a variety with high quality when fresh will not necessarily make a high-quality frozen pack. About the only way to tell whether a variety will freeze well is by actual tests.

In recent freezing tests by the Departments of Horticulture and Food Technology, some new varieties and selections have been compared with older varieties. Fruit was grown under uniform cultural conditions on the Horticultural Farm at Urbana, and was selected for uniform maturity typical of the variety or selection at the second or third picking. Berries were hulled, washed, sliced, and packed (4 parts berries to 1 part sugar) in cardboard freezer cartons, then frozen and stored at −40° F.

An eight-member panel evaluated the thawed pack. Each sample was scored on a 9-point scale for flavor, off-flavor, flesh color, surface color, uniformity of color, texture, and seediness. Weighted evaluation scores for all varieties and selections tested are listed below.

Variety or selection	*Score*
Oregon-U.S. 2384	151.450
Eden	149.015
Northwest	147.430
Earlidawn	146.510
Pocahontas	142.910
Redglow	141.900
Bellmar	140.700
Tennessee Shipper	139.610
Tennessee Beauty	138.675
Dorsett	132.765
Blakemore	131.930
Surecrop	131.725
Dunlap	131.430
Dixieland	131.080
Pathfinder	130.470
Vermilion (B)	126.970
Stelemaster	126.800
Fairpeake	126.500
Sparkle	124.680
Vermilion (A)	122.895
Starkrimson	121.805
Mr. Big	121.140
Jumbo	120.125
Midland	118.300
Premier (B)	117.950
Temple	117.860
Premier (A)	115.435
Shasta	113.725
Jerseybelle	113.330
Fairfax	113.280
Empire	110.740
Catskill	110.690
Fairland	110.420
Erie	107.865
Gandy	107.550
Ambrosia	107.490
Robinson	106.990
Plentiful	106.370
Redstar	104.400
Aberdeen	104.200
Armore	93.150
Kardinal King (Robinson)	88.820

The range in freezing quality of these varieties is quite apparent from a glance at the list, and one can say with reasonable certainty that Oregon-U.S. 2384, Eden, and Northwest are much better than Aberdeen, Armore, and Kardinal King (Robinson). However, it is also obvious that there is very little difference between Eden and Northwest or between Northwest and Earlidawn, which, for all practical purposes, are then equally desirable. Similarly, Aberdeen is really no worse than Redstar. In other words, the closely ranked varieties are about equally good or bad. — *C. C. Zych and J. N. McGill*

Casein Glue Tested for Building Components

Since 1954 the Small Homes Council – Building Research Council has been developing various nail-glued structural components for dwellings. A major factor in chosing a glue is its resistance to water and moisture. Casein glue was chosen for assembling the components because of its low cost, its performance record dating back to the early 1900's, and its gap-filling properties.

To check the moisture resistance of the casein glue, a number of nail-glued trusses were subjected to outside conditions while supporting a roof load of 40 pounds per square foot. Since trusses are not normally exposed, the first ones tested were fabricated with interior-type plywood gussets. In all cases the glue in the plywood failed, causing collapse before the casein glue had visibly deteriorated.

A pair of 28-foot "W" trusses were therefore fabricated of exterior-type plywood. Casein glue without mold inhibitor was used. Two-headed nails were used to develop clamping pressure and were removed after the glue had cured.

The trusses were loaded with 40 pounds per square foot on the outdoor test floor (see picture). After 18 months only a slight deterioration in the casein glue was noted in areas where water had been trapped between the truss members. This leads to the conclusion that casein-glued components should be satisfactory in normal non-exposed areas — *D. H. Percival, Department of Forestry and Small Homes Council–Building Research Council*

Loaded truss on outside test floor.

FARM BUSINESS TRENDS

THE CHART on this page shows important trends in the incomes of farm and factory workers over the past 25 years. It is based on data published by the U. S. Department of Agriculture.

The three years 1938-1940 are used as a base equal to 100 percent. The lines on the chart, therefore, show changes in incomes from this base period.

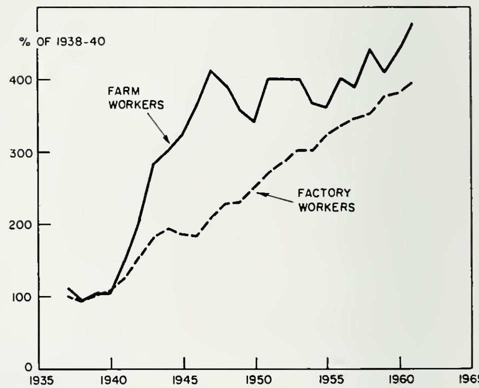
Use of 1938-1940 as a base period does not imply that the incomes of farm workers at that time were necessarily fair, or equal to those of factory workers. But the relationship between the incomes of farm and factory workers in those three years was typical of that which prevailed during the 21 years from 1920 through 1940.

As used here, farm workers include farm operators, other family workers, and hired labor. Factory workers include only those who were employed throughout the year.

The base period includes the last three years of the Great Depression. Over one-fifth of all nonfarm workers were unemployed. Agricultural employment was higher than it would otherwise have been, because the government was rapidly accumulating surplus stocks of farm crops under its price-support programs.

The chart shows a number of important facts about farm income:

1. The income of farm workers increased very rapidly from 1940 to 1947. This rise was caused by the inflation associated with World War II.
2. Farmers' income dipped from 1947 to 1950, as a result of postwar price readjustments. These readjustments included increases in farm-operating costs.
3. Farmers' income recovered in the early 1950's, as a result of the inflation accompanying the Korean War.
4. Farmers' incomes have trended upward since 1955.
5. For the last eight years the incomes of farm and factory workers have followed parallel trends. — *L. H. Simerl, Professor of Agricultural Economics*



Incomes of farm and factory workers in the United States, 1937-1961.

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Summer, 1962

ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

IN THIS ISSUE

Breeding new peach varieties requires continuous evaluation of trees and fruits during the growing season (page 6).

Volume 4, Number 3 UNIVERSITY OF ILLINOIS COLLEGE OF AGRICULTURE URBANA, ILLINOIS

ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

CONTENTS

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RESEARCH IN VETERINARY MEDICINE

is today asked to solve unprecedented problems embracing a great range of diseases — infectious, parasitic, metabolic, deficiency, hereditary, and toxic. The toxic group includes diseases due to contamination of the environment with radioactive substances, so-called agricultural poisons, and fossil fuel residues.

As a member of the animal kingdom, man may acquire many infectious and parasitic diseases from other species. Public recognition of this fact has resulted in a more realistic and effective attack on the zoonoses, or diseases common to man and other animals. Spearheading the attack are "teams" of scientists trained in veterinary medicine, medicine, other biological sciences, and such physical sciences as those concerned with soil, climate, and weather. The Illinois Center for Zoonoses Research (see ILLINOIS RESEARCH, Spring, 1962) was established in 1960 to wage more effectively the research battle against the inroads of disease.

The newer methods and instrumentations of research afford invaluable tools in the struggle against disease; yet genuine gains against the various forms and adaptations of disease have not been great. Jet transport may accidentally carry an infectious agent from one part of the world to any other part within 20 hours. The "population explosion" favors greater contact among all members of the animal kingdom, thus greatly facilitating the spread of contagions. Man-made changes in environment result in adaptations and mutations of disease agents, so that new and baffling variations continue to appear. It is therefore essential that veterinary medical research continue to expand and increase its productiveness. — *C. A. Brandly, Dean of the College of Veterinary Medicine*

Before accepting his present position in 1956, Dean Brandly was Head of the Department of Veterinary Science, University of Wisconsin. His previous experience included three years (1936-1939) as an associate professor at Illinois. He was named "Illinois Veterinarian of the Year" in 1958.

LIMITED FEEDING for HOGS

Leaner pork can be produced by reducing the feed intake of hogs during the finishing period

D. E. BECKER

Lard has become the curse of the swine industry. Public interest in "streamlined figures" and an association of fatty foods with heart disease have made the consumer discriminate against lard, oil, and fat cuts of meat.

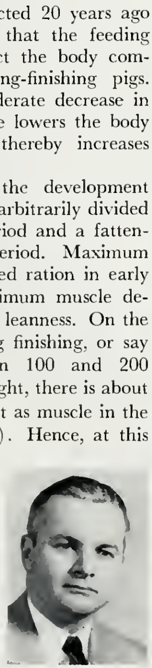
As a result, hog producers have placed great emphasis on the selection of breeding stock with meaty characteristics. Great strides have been made in decreasing the fat content of the hog carcass. However, further progress is necessary to reverse the trend of a decreasing per capita consumption of pork.

Nutrition as a solution

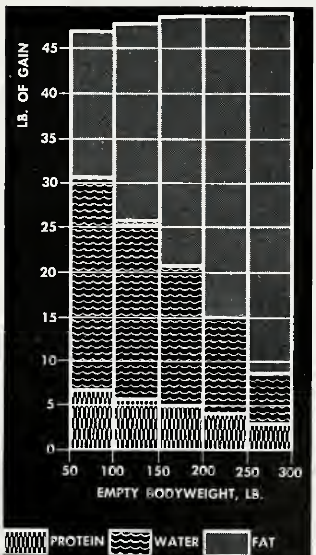
Research conducted 20 years ago provides evidence that the feeding program can affect the body composition of growing-finishing pigs. Specifically, a moderate decrease in daily caloric intake lowers the body fat content and thereby increases carcass leanness.

Physiologically, the development of the pig may be arbitrarily divided into a growing period and a fattening or finishing period. Maximum intake of a balanced ration in early life will give maximum muscle development or body leanness. On the other hand, during finishing, or say the stage between 100 and 200 pounds of bodyweight, there is about 5 times as much fat as muscle in the body gain (Fig. 1). Hence, at this stage, restricted energy intake reduces fat deposition but still permits growth or formation of lean tissue.

D. E. BECKER, Professor of Animal Science, received his B.S. and M.S. degrees from the University of Illinois and his Ph.D. from Cornell University. He returned to Illinois as a staff member in 1950.



Of course, limited feed intake during the finishing period does lower the rate of gain, which slightly lengthens the feeding period. But the increased body leanness, besides improving potential market value, allows the pig to make more efficient gains, since a pound of gain as lean requires only about half as much feed as a pound of gain as fat. This is true in spite of the longer feeding period during which extra feed is required for maintenance. Research to date indicates that the improvement in feed efficiency alone may amply justify limited feeding of finishing pigs.



Amounts of fat, protein, and water in the gain of pigs at various stages of development. Most of the water goes into lean meat. Small amounts of gain consist of ash. (Fig. 1)

Methods of limiting feed

Although we have been aware of the merits of limiting the feed intake of finishing pigs for some time, swine producers have not adopted the practice. In the first place, they have had little incentive to produce meaty hogs, since the packer has not always rewarded quality at the selling block. Secondly, limiting the amount of feed means hand feeding and hence more labor.

Assuming that the improved efficiency resulting from a limited energy intake was ample to justify the practice, the Department of Animal Science has conducted experiments to study methods.

One experiment was conducted to determine whether feeding a bulky ration free choice would restrict energy intake as effectively as feeding a limited amount of standard ration. Sixty crossbred pigs weighing 106 pounds at the start of the test were used.

Control pigs were full-fed with a fortified corn-soybean meal ration containing 12 percent protein. One lot of pigs was limited to 85 percent of full feed; and another, to 70 percent. They were fed twice daily in open troughs.

Three lots received rations that were 25 percent bulky ingredients. These ingredients had replaced an equal amount of ground corn in the control ration. The bulky rations were fed *ad libitum* from self-feeders.

Pigs on both the bulky rations and the restricted rations had a higher percentage of lean than the control pigs (Table 1). However, adding the fibrous feeds reduced the efficiency of gain as well as the rate of

Table 1. — Feeding Bulky Rations and Limiting Feed Intake for Finishing Pigs[a]

Item measured	Control ration full-fed	Rations containing 25% of — Ground corn cobs	Wheat bran	Alfalfa meal	85% of full feed	70% of full feed
Av. daily gain, lb.	2.15	1.69	1.96	1.74	1.77	1.59
Days to 200 lb.	45.1	58.4	50.0	55.6	54.9	60.7
Feed per lb. gain, lb.	3.46	4.86	3.58	4.49	3.47	3.12
Av. lean cuts, %	49.0	52.3	50.1	50.0	50.4	50.4

[a] Average initial weight 106 pounds; 10 pigs per lot.

Table 2. — Two Methods of Limiting Feed Intake of Finishing Pigs[a]

Item measured	Full-fed	70% of full feed	5 lb. feed per head daily
Av. daily gain, lb.			
16% protein	1.86	1.47	1.52
12% protein	1.92	1.54	1.54
Average	1.89	1.50	1.53
Days to 200 lb.	46	56	56
Feed per lb. gain, lb.			
16% protein	3.58	3.09	3.28
12% protein	3.53	3.17	3.25
Average	3.56	3.13	3.26
Av. lean cuts, %			
16% protein	46.6	47.1	47.9
12% protein	45.8	47.0	47.5
Average	46.2	47.0	47.7

[a] Average initial weight, 113.9 pounds; 13 pigs per lot.

gain, while restricting the intake reduced only the rate of gain. Efficiency of gain was not affected at 85 percent of full feed and was improved at 70 percent.

Thus, it was better to feed a limited amount of concentrated ration than to feed bulky rations *ad libitum.*

Constant feed intake

On the basis of the above results, we conceived the idea of feeding a constant level of feed daily during the finishing period. Thus the pig would be nearly full-fed at 100 pounds liveweight and limited to about 55 percent of full feed at 200 pounds liveweight — the average being about 70 percent.

This plan has two advantages. It limits the pig most severely at a stage when most of the fat is stored, and it offers the possibility of a simplified feeding scheme. Feed level would not have to be adjusted upward as bodyweight increases.

An experiment was accordingly conducted to compare feeding at a constant rate of 5 pounds a head daily, at 70 percent of full feed, and at full feed. Seventy-eight Duroc or crossbred barrow pigs weighing approximately 114 pounds were used. Before the start of the study, the pigs had been fed adequate rations and showed normal gains. They were allotted at random to the three treatments. Fortified corn-soybean meal rations containing two levels of protein were used. Pigs on limited rations were fed twice daily in open troughs.

As in the first experiment, restricting the feed intake to 70 percent of full feed reduced the rate of gain by about 20 percent (Table 2). Feeding a constant level of 5 pounds per head daily had a similar effect. By either method pigs making the slower rate of gain needed only 10 extra days to reach a weight of 200 pounds.

Again, limiting the feed intake increased the feed efficiency, or decreased the feed required per pound of gain, by approximately 10 percent. Furthermore, the limited-fed pigs had better carcasses than the full-fed pigs.

More protein necessary?

Nutritionists normally recommend that pigs be fed about 12 percent protein from 100 to 200 pounds bodyweight. When feed intake is restricted to 70 percent of normal, it might be reasoned that the percentage of protein should be increased by about 25 percent to satisfy the pig's needs. However, as indicated by the data in Table 2, such does not seem to be the case. Pigs fed 12 percent protein were as efficient in gaining and as desirable in carcass characteristics as those fed 16 percent protein.

The University is experimenting with ways of reducing feed intake automatically. (Fig. 2)

The future of limited feeding

Certainly selection procedures have improved the carcass merit and efficiency of hogs in production today. However, according to the evidence, even the best breeding stock will have a leaner carcass and make more efficient gains on limited feed than on full feed during the latter stages of development. Therefore, with the current emphasis on leanness and efficiency, restricted feeding will quite likely become a part of practical swine production.

Only the "hand-feeding" barrier remains, and it seems certain that this barrier will be broken within a short time. Equipment manufacturers and university researchers are studying mechanized facilities for providing limited amounts of feed automatically (Fig. 2). In addition, the possibility of offering pigs a limited time at the self-feeders is being explored.

Establishing Spring-Seeded Lawns

H. R. KEMMERER and J. D. BUTLER

More than 18 million dollars is spent every year for lawn and turf establishment in Illinois.

A large part of this goes for establishing spring lawns even though fall is considered the best time for seeding. The Department of Horticulture has therefore been investigating spring lawn establishment.

An advantage of spring seeding is that the grass usually needs less watering than fall-seeded grass. A big drawback to spring seeding is the competition from weeds, especially crabgrass.

Soil fumigants

A drastic and not commonly used method of combatting weeds in the new seeding is to kill the weed seeds with soil fumigants such as methyl bromide, Mylone, calcium cyanamide, and Vapam (Table 1).

For best results with fumigants, soil temperature should be at least 65° F. The soil should be moist, but not overly wet. It should be tilled 6 inches deep, so that the fumigants can penetrate it easily.

Grass can be seeded a couple of days after methyl bromide is used. With the other materials, seeding should be delayed a few weeks.

Different treatments tried

Experimental trials were conducted last year to determine how rate of seeding, fertility treatment, and chemical and mechanical weed control affected grass coverage. On May 18, Kentucky bluegrass was seeded at five rates: 1/10, ⅕, ½, 1½, and 3 pounds per 1,000 square feet.

Ten pounds of 10-6-4 per 1,000 square feet were applied before working the soil. A third of the plots received no additional treatment; another third received 10 pounds of 10-6-4 at the time of seeding and on July 13; and a third received 20 pounds on these two dates.

The whole area was sprayed with 2,4-D amine on July 14. This gave perfect control of broadleaf weeds.

On August 3, a vertical cut (Henderson) mower was used on parts of the plots for crabgrass control. Others received treatment with disodium methyl arsonate (Sodar). One pound of material was used in 25 gallons of water, and 2 gallons of this solution were applied to a 210-square-foot plot. Treatment was repeated 7 days later. The irrigation system was turned on in the evening after the arsonate was applied in the morning.

All plots were irrigated throughout the summer and kept mowed to a height of 2 inches. Coverage was determined on September 15.

Results with Kentucky bluegrass

Without any weed control, the 3-pound seeding rate and the highest fertility level produced the best cover of Kentucky bluegrass (Table 2). However, even this cover — 33 percent — was not good.

Best results were obtained with chemical weed control. The cover was about as good with a 1½-pound seeding rate as with the 3-pound rate. Increasing the amount of fertilizer above the 10-pound rate did not appreciably affect results.

Similarly, with mechanical weed control (vertical cut mower), results of the 1½- and 3-pound rates of seeding were about the same, and increasing the fertility treatment did not greatly increase the cover.

Results with Merion bluegrass

Similar experiments were conducted with Merion Kentucky bluegrass. Again, chemical crabgrass control gave the best cover. The ½-pound seeding rate was generally as good as the 3-pound rate. The cover produced with this seeding rate and chemical control was comparable to that from 1½ pounds of Kentucky bluegrass (Table 3).

H. R. Kemmerer is Assistant Professor and J. D. Butler is Assistant in Horticulture.

Table 1. — Astoria Bent Cover in November After Treatment With Fumigants on May 19 and Seeding on June 19 (½ lb./1000 sq. ft.)

Material	Rate per 1,000 sq. ft.	Percent coverage
Mylone (Barber's Pre-Plant)	13⅓ lb.	99
Methyl bromide (MC-2)	10 lb.	95
Vapam (VPM)	2½ gal.	94
Calcium cyanimide (Aero)	80 lb.	81
No treatment	......	78

Table 2. — Kentucky Bluegrass Cover After Various Treatments

Seeding rate (lb./1,000 sq. ft.)	Fertility level[a]		
	10	30	50
NO WEED CONTROL			
	Percent cover		
1/10	1	0	6
1/5	0	0	12
½	7	2	6
1½	12	8	25
3	17	22	33
DSMA TREATMENT[b]			
1/10	14	4	12
1/5	24	6	18
1/2	38	30	23
1½	68	69	71
3	68	70	73
VERTICAL CUT MOWER			
1/10	5	1	7
1/5	8	4	13
1/2	31	27	16
1½	39	44	54
3	40	39	42

[a] Pounds of 10-6-4 per 1,000 square feet.
[b] Disodium methyl arsonate.

Table 3.—Merion Kentucky Bluegrass Cover After Various Treatments (Seeding rate — ½ lb./1,000 sq. ft.)

Treatment	Fertility level[a]		
	10	30	50
	Percent cover		
Mechanical	11	13	13
Chemical	88	63	61
No treatment	7	0	1

[a] Pounds of 10-6-4 per 1,000 square feet.

Growers' problems important in the ILLINOIS PEACH BREEDING PROGRAM

J. B. MOWRY

PEACH BREEDING has been investigated for more than half a century at the Illinois Agricultural Experiment Station. The result has been the introduction of several new varieties, as well as basic knowledge about the genetics of the peach.

The first 40 years

At first the emphasis was on basic research. Studies included the manner in which horticultural characteristics are inherited and the linkage relationships between these characteristics; the genetic makeup of parent varieties; and the construction of chromosome maps. A second objective was to originate improved peach varieties that would mature over a long season. Investigations were conducted at Urbana and at the Peach Breeding Farm near Olney.

C. S. Crandall directed the program from 1908 until 1925, when M. J. Dorsey assumed the responsibility. In 1943 J. S. Whitmire, C. E. Chaplin, and L. F. Hough were added to the list of personnel. That same year the project was revised; and greater emphasis was placed on originating cold-hardy, disease-resistant new varieties.

Much of the earlier activity was terminated in 1946 with the introduction of seven new varieties: Prairie Dawn, Prairie Sunrise, Prairie Rose, Prairie Daybreak, Prairie Schooner, Prairie Clipper, and Prairie Rambler. Only the first three of these now appear to have value for commercial production. Prairie Dawn, in particular, is widely recognized for bud hardiness, resistance to bacterial spot, and attractive, good-quality fruits. It is in demand in extreme northern peach-growing districts, being especially valuable for roadside markets.

The fruits of all the Prairie varieties have only a moderate amount of red color. At present this is a great disadvantage for freestone peaches intended for the wholesale fresh market.

Revised in 1948

The peach breeding project was further revised in 1948 under the direction of C. J. Birkeland and C. E. Chaplin. In 1952 the author and D. F. Dayton became leaders of the project.

The original objectives have been retained in the present program, but the order of priority has been changed. Now the primary objective is to originate varieties maturing at closely spaced intervals. Characteristics such as disease resistance, bud hardiness, productivity, and fruit firmness, size, attractiveness, and freestone are most intensively evaluated.

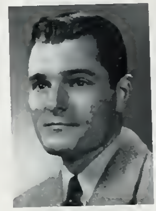
The second objective is to study the inheritance of major tree and fruit characteristics. About 30 states support peach breeding projects, but Illinois is one of very few that remain officially interested in genetic studies of the peach.

Since 1948 much of the work has been done at the Illinois Horticultural Experiment Station, Carbondale. When the Peach Breeding Farm at Olney was sold in 1951, all the surviving seedlings and selections were propagated at Urbana and planted at Carbondale.

Production in Illinois

Commercial peach production in Illinois is mainly concentrated in several areas south of highway U. S. 40, which follows a line from East St. Louis to Terre Haute, Indiana. Small concentrations north of this line are located primarily in Calhoun and Jersey counties.

J. B. Mowry, Professor of Horticulture, is jointly employed by the University of Illinois and Southern Illinois University as Superintendent of the Illinois Horticultural Experiment Station, Carbondale.



Illinois production averaged about 861,700 bushels a year between 1950 and 1960. Practically all Illinois peaches are freestone and sold in the fresh state. Five varieties account for about 91 percent of the crop: Elberta, 45 percent; Redhaven, 16; Rio Oso Gem, 15; Redskin, 9; and Halehaven, 6.

The wholesale fresh peach marketing season in the United States and Canada is 16 weeks long. The bulk of the Illinois crop is marketed in the eleventh week of the season. This is a favorable time, for the national supply is below average. However, Elberta peaches, which make up so much of the Illinois crop, appear less attractive than other varieties on the national market at the same time, and so cannot compete effectively with them. Today, fresh fruit is usually sold according to the consumer's snap judgment as to relative attractiveness of available fruits.

Other problems have resulted from the predominance of Elberta in Illinois. The flood of these peaches within a very limited time is difficult to market in an orderly way, and the prices received are generally close to the cost of production and packing. Practically none of the peaches can be temporarily withheld from the market because they don't hold well in cold storage; and an alternate commercial processing market is not available. Furthermore, many house-

The Comanche peach, originating from a cross of Vedette × Halehaven made in 1937, was introduced in 1958 by the Illinois Agricultural Experiment Station.

After flowers have been artificially pollinated, the parent trees are usually protected by large bags or tents until petal fall.

wives no longer buy large amounts for home processing.

Many growers have too many Elberta trees for proper harvesting and packing with their machinery and labor resources. Thus, they have to start harvesting too early and market a grossly immature, poorly colored peach, to avoid overripe fruit near the end of their harvest. Consumers are critical of poorly colored fruit, and wholesale buyers will not accept the overripe fruit.

Growers could greatly reduce most of their problems by planting several recommended, highly colored varieties that mature over a longer season. They could then utilize labor and machinery more efficiently in packing and harvesting, spread marketing over a longer period, and produce more attractive fruit.

Season for new varieties

Prolonging the harvest season is thus a very important goal in breeding new peach varieties. However, most potential parent varieties maturing earlier than 4 weeks before Elberta tend to produce fruits that are small, only moderately firm, of fair quality, and clingstone, even though they are highly colored. Furthermore, maturity is not uniform. Late varieties maturing more than 2 weeks after Elberta usually have large, freestone fruits, but they are unattractive, poorly colored, and only fair in quality. Neither the very late nor the very early varieties grown in Illinois can compete effectively with midseason varieties on the national market at the same times.

Generally speaking, the best combination of marketing characteristics is found in varieties that mature from 4 weeks before Elberta to 2 weeks after. Our breeding work is thus aimed at selecting varieties to mature at closely spaced intervals within this period. Further selection is for productivity, flower bud hardiness, resistance to bacterial spot, and fruits that are large, highly colored, attractive, firm, yellow-fleshed, nonbrowning, and freestone.

Breeding operations

Appreciation of the specific characteristics of the parents must be the first step in any breeding program. Since 1951 at the Illinois Horticultural Experiment Station, about 350 peach varieties and numbered selections have been extensively tested and evaluated for adaptability to southern Illinois.

Every year each tree is scored for 27 tree and fruit characteristics. Another 25 characteristics such as bud hardiness and disease resistance are evaluated whenever a good opportunity to distinguish varietal differences is presented. This backlog of experience is essential to judge the performance of new plant types acquired by the continual introduction of new varieties and selections and by the production of seedling progenies in the breeding program.

Controlled pollinations are conducted each year between parent stocks selected according to our evaluations of the varieties and seedlings. So far nearly 5,000 seedlings obtained from controlled pollinations have been planted at the Horticultural Experiment Station. Fruiting seedlings are evaluated each year and selections made for potential new varieties or potential parents that will transmit specific characteristics in additional crosses. About 100 selections have been established.

At the same time we are spending considerable effort in genetic analyses of the inheritance of specific characteristics: flower bud hardiness, leaf gland types, flower types, resistance to bacterial spot disease, stone adhesion, flesh firmness, and oxidative browning of the flesh.

For judging some characteristics we have to invent new techniques or modify existing ones.

New variety introduced

A number of early Illinois selections were sent to widespread state experiment stations for evaluation under different conditions. One selection (K-76) favorably impressed growers and research men in Texas because of its regular production of large, round, attractive fruits.

In 1958, K-76 was named Comanche, and scions were released to the nursery trade. Comanche shows promise for replacing Redhaven in southern peach-growing regions, but is not an outstanding improvement over Redhaven under Illinois conditions.

Breeding tree fruits is a long-term project, and 25 years may elapse before a new peach variety is adequately tested and is accepted by commercial growers. Satisfactory progress, however, has been made in Illinois. Along with our hybridization and selection, we continually evaluate new varieties from other breeding programs. These two types of work are equally important in improving the Illinois peach crop.

HOW CORN USES NITROGEN

R. H. HAGEMAN

GREATER USE of nitrogen fertilizers has played a big part in the increased corn yields of the last decade.

Nitrogen is essential for a plant's growth and development. Plants combine reduced nitrogen, or the ammonium ion, with keto acids (partially oxidized glucose) to form amino acids, needed for protein synthesis. Animals and humans cannot fabricate the essential amino acids and must get them from plants.

Corn absorbs nitrate

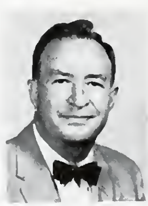
Most of the nitrogen absorbed by the corn plant is in the oxidized (nitrate) form. Actually, corn can absorb and assimilate the reduced (ammonium) form of nitrogen just as easily as nitrate. But when ammonium fertilizer is applied, nitrifying organisms in the soil quickly convert it to nitrate. The process is especially rapid just when soil temperature and moisture are right for optimum growth of corn.

We haven't determined precisely the relative proportions of nitrate and ammonium ions absorbed by plants under field conditions. However, the predominance of nitrate is indicated by the high amounts found in the plant.

How the corn plant uses this nitrate to manufacture amino acids has been investigated by the Agronomy Department since 1956.

Shading increases nitrate

In early experiments, nitrate was especially high in plants that had been shaded by artificial structures or by increased plant populations.



R. H. Hogemon, Professor of Plont Physiology, come to Illinois from the University of Colifornio, where he received his Ph.D. degree in 1953. He hod previously done reseorch in Puerlo Rico.

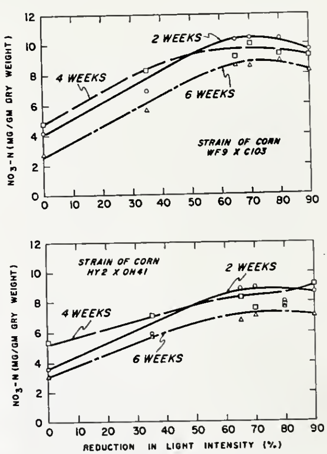
This suggested that a reduction in light intensity retarded nitrogen metabolism, or the rate at which the plant converts nitrate into amino acid. Nitrate accumulation was greater in hybrid WF9 × C103 than in hybrid Hy2 × Oh41 (Fig. 1).

Shading also reduces the plant's fixation of carbon dioxide through photosynthesis. As a result, the levels of carbohydrates and sugars in the plant are lowered. However, according to data from the artificial shading experiments, carbohydrate level was not the primary factor limiting nitrogen metabolism.

On a fertile soil, plants grown at a rate of 28,000 an acre had more nitrate than plants grown at a rate of 4,000 an acre. This was despite the fact that at the higher planting rate seven plants competed for the same amount of nitrogen available to one plant at the lower rate.

Planting rate did not significantly affect carbohydrate content, although mean values tended to be lower in plants grown at the thicker rate. Citric acid, a precursor of a critical keto acid needed to form amino acids, was slightly higher in the shaded plants.

Evidence from the experiments with both artificial and competitive shading suggests that nitrogen metabolism is more sensitive to decreased light intensity than is photosynthetic fixation of carbon dioxide.



Effect of artificial shade on nitrate content of two corn hybrids. (Fig. 1)

Enzyme inactivated

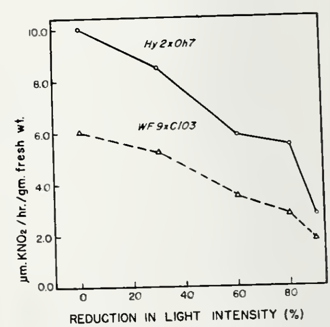
Subsequent experiments demonstrated that reduction in light intensity inactivated an enzyme, nitrate reductase, which is necessary for nitrogen metabolism (Fig. 2).

In other experiments corn plants lost 90 percent of their nitrate reductase activity when placed in complete darkness for 48 hours. The activity returned rapidly when the plants were re-exposed to light.

Nitrate reductase activity, water-soluble protein, and nitrate levels all varied with the time of day (Fig. 3 and table on page 9).

As can be seen from Figures 2 and 3 and the table, the hybrid Hy2 × Oh7 had more nitrate reductase activity and protein content than hybrid WF9 × C103, and also had a greater variation in nitrogen metabolism during the day.

Nitrate reductase activity in both hybrids correlated positively with



How shading corn plants for 2 weeks affected nitrate reductase activity. Samples were taken at midday when plants were about 10 weeks old. (Fig. 2)

protein content and negatively with nitrate content. These results established that test tube measurements of the amount of enzyme reflect the nitrogen metabolism in the plant.

In this series of experiments, nitrate content was lower in plants grown at the thick rate than in those grown at the thin rate. This result does not agree with results of the preceding tests, and can be attributed to an inadequate level of soil nitrogen. Later experiments by the Departments of Agronomy and Animal Science have consistently demonstrated that where soil nitrogen is not limiting, thick planting will increase nitrate content.

Nitrate reductase activity has been shown to be related to the amount of nitrate supplied. (In technical terms, this is known as substrate dependency.) It has also been noted that nitrate reductase activity virtually disappears when environmental conditions cause plants to wilt or roll their leaves.

From nitrate to amino acids

To produce amino acids, the plant first has to reduce nitrate to the ammonium ion. Much information is still lacking on the biochemical mechanism of this reduction. The following sequence for the reduction of nitrogen by the plant has been proposed but has not been completely established: nitrate → nitrite → hyponitrous acid → hydroxylamine → ammonium ion.

Although the plant can accumulate relatively high levels of nitrate, presumably without toxicity, the other four intermediates are considered to be toxic and are never found in high accumulations in healthy corn tissue. From this it may be argued that nitrate reductase, which reduces nitrate to nitrite, is the "pace setter" or regulator for the entire pathway of nitrogen metabolism. Once the reduction process is started, it carries to completion and the ammonium ion is combined with a keto acid to produce an amino acid. The close correlation between nitrate reductase activity and protein content supports this argument.

Each of the four steps in the pathway from nitrate to ammonium is catalyzed by an enzyme or enzyme system. Although much is known about nitrate reductase, which carries out the first step, relatively little is known about the others. Early this year, an enzyme or enzyme system was extracted from corn plants that reduces nitrite and hydroxylamine to the ammonium ion. Research workers are now trying to exploit this lead.

Possible role of ammonium

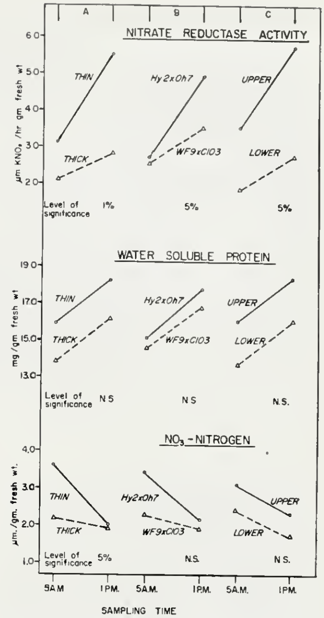
Since nitrate has to be changed to ammonium for the production of amino acid, and since the corn plant can absorb ammonium ions from the soil, it might seem that steps should be taken to supply only the ammonium form of nitrogen. This argument, however, is not completely valid.

First, corn plants in nutrient culture have grown better under most conditions when supplied with nitrate rather than ammonium salts. Second, according to experimental evidence, the reduction of nitrate in the plant may be useful in oxidation-reduction reactions, thereby maintaining a more balanced metabolism. Even if ways could be found to supply only the ammonical form of nitrogen to the plant, optimal growth and yield might not result.

On the other hand, adding small amounts of ammonium to the plant, thereby supplementing the available nitrate in the soil, might be the best way to by-pass a lagging nitrate reductase system, and increase growth and yields.

A new selection tool?

Another aspect of this research is that the nitrate reductase activity of hybrids Hy2 × Oh7 and WF9 × C103 correlates with their yield. E. R. Leng and E. B. Earley have found that Hy2 × Oh7 consistently outyields WF9 × C103 both with and without artificial shade. Research is being continued to see if measurements of nitrate reductase activity can be a selection tool in developing superior hybrids.



Variations during the day in nitrate reductase activity, water-soluble protein, and nitrate content as affected by (A) planting rate, (B) hybrid, and (C) leaf position. (Fig. 3)

Effects of Different Variables on Nitrate Reductase, Nitrate, and Water-Soluble Protein

	Reductase activity[a]	Protein[b]	Nitrate[c]
Diurnal variation (mean values of both hybrids, leaf positions, and planting rates)			
5 a.m.	2.6	14.8	2.8*
1 p.m.	4.2**	17.2**	2.2
Planting rate (mean values of both hybrids, leaf positions, and sampling times)			
Thin	4.3**	17.0**	2.7*
Thick	2.5	15.0	2.1
Leaf position (mean values of both hybrids, sampling times, and planting rates)			
Top	4.6**	17.1**	2.7*
Bottom	2.2	14.9	2.1
Hybrid (mean values of both leaf positions, sampling times, and planting rates)			
WF9 X C103	3.0	15.6	2.1
Hy2 X Oh7	3.8**	16.4*	2.7*

[a] Micromoles of KNO_3 reduced per hour, per gram of fresh weight.
[b] Milligrams per gram of fresh weight.
[c] Micromoles of nitrogen per gram of fresh weight.
* Significantly higher at 5 percent level.
** Significantly higher at 1 percent level.

A New Lipid Laboratory for Research on Diet and Aging

Model of the Burnsides Research Laboratory, which is now being constructed at Pennsylvania and Goodwin Avenues. The finished building will have a penthouse, not shown on the model. Dr. Kummerow has been named director of the new laboratory.

F. A. KUMMEROW

More people than ever can now look forward to reaching the age of 80 or more. Our increased life span is, of course, due to the control or conquest of a host of diseases, including typhoid fever, small pox, bubonic plague, and nutritional diseases such as rickets, scurvy, beriberi, and pellagra.

Now research workers are turning more of their attention to gerontology, or the health problems of the aged. The immediate goals of research in gerontology are to find cures for cancer and atherosclerosis. However, even if both these diseases are conquered, the problems of old age will still be with us. The important thing to most of us is not just to live to a "ripe old age," but to do so in a vigorous state of health and not as a semi-invalid.

The aging process is due to subtle biochemical changes, which proceed at different rates in different people. Some individuals are as "old" at 40 as are others at 70. Nobody knows yet whether the biochemical changes of aging can be controlled. But studying these changes and their causes is certainly a basic part of gerontological research.

In the Department of Food Technology research is being conducted on the relationship between diet and the aging process, including the development of atherosclerosis.

Knowledge needs to be applied

While we have much to learn about diet and aging, we are not as a people applying the knowledge that we do have about nutrition. For example, research in the agricultural experiment stations has made possible a land of "milk and honey" to the point where about 600 million dollars will be spent on "surplus" dairy products in 1962. Yet if the facts of nutrition, as we know them today, were applied to our population, this expenditure would be unnecessary. The surplus milk products would be consumed by our teenagers to supply the essential protein and calcium for growth. A good diet during the teen years will certainly help to insure good health in later life.

Some facts about dietary fat

One point on which there has been quite a bit of misinformation — or misapplication of information — has been the role of fats in the diet.

It is commonly known that dietary fats represent the most compact chemical energy available to man. They have twice the caloric value of an equivalent weight of sugar. However, they should not be considered merely as providers of unwanted calories or the possible cause of fatty deposits in the arteries. For fats are as vital to cell structure and biological function as protein. What is important to remember is that if an individual eats food high in fat, he must also have enough protein and vitamins to provide the lipotropic factors for normal fat metabolism.

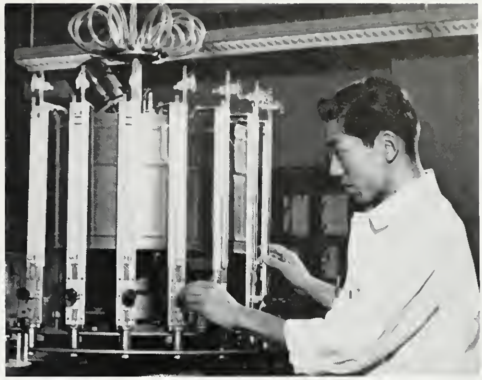
One important constituent of dietary fats is linoleic acid. It seems to be essential for both the development and the function of animal tissue. Although the optimum total intake of linoleic acid by man has not been established, further research may indicate that the level of intake in the American dietary pattern could be increased.

It does not necessarily follow, however, that "soft" fats should be indiscriminately substituted for "hard" fats. For one thing, linoleic acid is present in all dietary fats. For another, excess consumption of highly unsaturated fatty acids (such as the daily consumption of ⅔ cup or 800 calories of corn or cottonseed oil, which is sometimes recommended) can have undesirable effects. It may change the functional value of the triglycerides in the depot fats (fats essential to body structure) and may put an undue stress on the antioxidant supply available in the body. Furthermore the consumption of 800 calories from corn oil will provide too much fat and not enough protein. This is especially true if the intake of meat, eggs, and dairy products is reduced and no substitute protein from vegetable products is consumed.

If obesity is a problem, the answer is not to resort to periods of semi-starvation. Nor is it wise to drastically decrease the proportion of fat in the diet. In fact, this could increase hunger pangs and hence make a person consume more total calories. The excess calories furnished by carbohydrates in a low-fat diet can be converted to fat in the body.

The best way to solve the problem of obesity is to reduce one's total calories while eating a balanced diet. Such a diet would include enough meat, milk, eggs, vegetables, fruits,

F. A. Kummerow, Professor of Food Chemistry, and Toshiro Nishida, Assistant Professor of Food Technology, check data from the model E ultracentrifuge.



Hiroshi Kumura, a student from Japan, adjusts the levels of manometers on Warburg flasks containing tissue extracts from experimental chicks.

cereals, and bread to provide for an adequate intake of protein, vitamins, and calories.

Many questions remain as to the role of diet in preventing atherosclerosis. Since fats have been found in damaged areas of the arteries, a study of the relationship between dietary fats and the development of these areas is important.

New laboratory

Research on diet and aging at the University will be accelerated when the new Burnsides Research Laboratory is completed. It will have two functions: to do basic research on gerontology and to train research workers in this area.

The new laboratory was made possible by a gift of $250,000 from Miss Ethel Burnsides, a retired nurse of Paris, Illinois. Additional funds have come from the National Institutes of Health, a part of the U. S. Public Health Service; and from University of Illinois capital appropriations.

The building is now under construction and is scheduled for completion no later than January 1, 1963. It will consist of two main stories, a basement, and a penthouse, with a total area of 21,232 square feet.

The basement will have these facilities: four small-animal rooms grouped around a central wash-up room and a room for diet formulation; a centrifuge room next to a ventilated cold room and freezer; two rooms equipped with walk-in hoods and their own ventilation systems, for work with radioactive compounds; and small service areas for tissue culture work, gas chromatography, and instrument repairs.

The first floor will be devoted entirely to research areas grouped around a central instrument room. On the second floor, research areas will be grouped around a library and study room. The penthouse will be a reading and seminar room.

Sources of operating funds

A number of organizations have provided grants to support students and staff as well as provide money for supplies and equipment. These organizations are: the National Institutes of Health, Illinois Heart Association, American Heart Association, American Dairy Association, Pure Milk Association, National Live Stock and Meat Board, National Science Foundation, and several Illinois county groups.

Training future workers

A grant from the National Science Foundation and the Illinois Heart Association assures support for 16 high-ability, high school juniors during the current summer session. These students are working in the laboratory on regular research projects. It is hoped that after graduating from high school they will enrol in a field of science at the University of Illinois. This program has received an enthusiastic response and we hope it can become part of our regular training and research program.

Jim Sgoutas, from Greece, runs gas chromatographs of lipid samples. This is a method of testing the purity of compounds or identifying fatty acids in the blood.

POPULATION Growth in Metropolitan Illinois

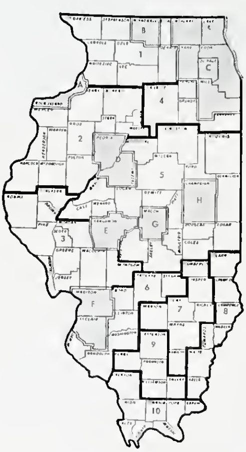
C. L. FOLSE

Most of Illinois's population growth during the past 20 years has been in just 15 counties.

These 15 counties lie in the eight metropolitan areas of the state as designated by the Bureau of the Census (see map). Between 1950 and 1960 these areas gained 1,315,870 inhabitants, representing a 20.7 percent increase. This was 96 percent of the state's total growth of 1,368,982 during the decade. From 1940 to 1960 these areas absorbed 98.4 percent of a 2.2 million increase in the state. This dramatic growth in metropolitan population is typical of the nation as a whole.

By contrast, the 51 most rural counties in Illinois lost 82,536, or 7.9 percent, of their population between 1950 and 1960. The other 36 counties gained 135,648, or 11.0 percent. Net gain for the 87 nonmetropolitan counties was 53,112 (2.3 percent).

Six of the standard metropolitan areas have their central cities within the state. However, the central city for Area A is Davenport, Iowa; and for Area F, St. Louis, Missouri. Since this analysis is concerned only with Illinois, Rock Island-Moline are treated as the central city for Area A, and Belleville-East St. Louis as the central city for Area F.



Standard metropolitan statistical areas, indicated by letters, and nonmetropolitan areas, indicated by figures.

Variations in growth

While the total population increase in the eight areas was extremely important, areas varied markedly in rate of growth. The Decatur, Peoria, Rock Island, and Springfield areas grew less than 20 percent between 1950 and 1960. The other four areas grew more than 20 percent, with the Rockford area having the highest rate — 37.7 percent.

Within each metropolitan area, rate of growth in the central city varied markedly from that outside the city (Table 2). Between 1940 and 1960 the increase in the central cities was only 7.4 percent, while that outside the cities was 15 times as great, or 111.4 percent. In 1940 about 1.6 million people lived in the metropolitan areas outside the central cities; by 1960 the number had grown to 3.5 million.

All the central cities except Peoria increased in population between 1940 and 1960. The largest percentage increase was in Champaign-Urbana, the only city that grew faster than the surrounding area. However, college students were counted as residents of Champaign-Urbana in 1950 and 1960, having been counted in their home communities for earlier censuses. Without that change, Champaign-Urbana would have lost population while the surrounding area gained.

How areas grow

Annexing new territory and populations by extending corporate boundaries is an important factor in the growth of cities. Between 1950 and 1960, annexations contributed greatly to population increases in all the central cities except Chicago and Peoria.

Births, deaths, and migration had varying effects on population within and outside the central cities. Natural increase (excess of births over deaths) amounted to 1,002,190, or 76.2 percent of the total 1950-1960 population gain in the metropolitan areas. About 52 percent of the natural increase was within the central cities.

In 1950-1960, the metropolitan areas gained 313,680 through migration, with a net loss of 539,548 in the central cities and a gain of 853,228 outside the cities (Table 2). Five central cities lost through mi-

Table 1. — Population Changes in Illinois Standard Metropolitan Statistical Areas and Nonmetropolitan Areas, 1950 to 1960

Area	No. of counties	Census 1960	Census 1950	Change: Number	Change: Percent
Metropolitan areas, total	15	7,754,932	6,439,062	1,315,870	20.4
A. Rock Island-Moline[a]	1	150,991	133,558	17,433	13.1
B. Rockford	1	209,765	152,385	57,380	37.7
C. Chicago	6	6,220,913	5,177,868	1,043,045	20.1
D. Peoria	2	288,833	250,512	38,321	15.3
E. Springfield	1	146,539	131,484	15,055	11.5
F. East St. Louis-Belleville[b]	2	487,198	388,302	98,896	25.5
G. Decatur	1	118,257	98,853	19,404	19.6
H. Champaign-Urbana	1	132,436	106,100	26,336	24.8
Nonmetropolitan areas, total	87	2,326,226	2,273,114	53,112	2.3
Increasing counties	36	1,369,873	1,234,225	135,648	11.0
Decreasing counties	51	956,353	1,038,889	−82,536	−7.9
State total	102	10,081,158	8,712,176	1,368,982	15.7

[a] Illinois portion Davenport, Iowa, standard metropolitan statistical area.
[b] Illinois portion St. Louis, Missouri, standard metropolitan statistical area.

gration, while Rockford, Champaign-Urbana, and Decatur gained.

In the 1940-1950 decade, six cities lost population through migration; but the total loss for all cities was smaller than in 1950-1960. Similarly, in the four cities that lost through migration in both decades (Chicago, Peoria, Springfield, and Belleville-East St. Louis), the losses were smaller in 1940-1950 than in the following decade. Rock Island-Moline showed a slight migration gain in the earlier decade, but a significant loss by 1960. Rockford and Decatur showed the opposite trend, losing through migration in 1940-1960, but gaining in the next decade.

Population concentration

As the metropolitan areas have absorbed most of the state's population growth in the last 20 years, more people have been concentrated in a limited geographic area. The eight metropolitan areas have 9,788 square miles of land, or 17 percent of the total area in the state. Average population density in the 15 counties is 792 persons per square mile, including the rural as well as the urban areas in these counties.

More remarkable, and probably reflecting modern man's ingenuity in organizing social systems, is the fact that the average population density within the central cities (360 square miles) is 11,746 per square mile. Thus, 42 percent of the state's population occupies less than 1 percent of the land area. Population density in the suburban areas outside the central cities averages 3,736 persons per square mile.

Significance of urban growth

As the standard metropolitan areas dominate the population picture, they are also the focal centers of political, economic, and cultural life, reaching out and influencing all areas of the state.

Of more immediate concern is the impact that the urban explosion has on rural areas contiguous to metropolitan areas. As urban industrial workers move into traditional rural communities and open-country agricultural areas, they create problems for expanding local facilities, particularly drainage, sewage, water resources, schools, churches, and health services. Conflicts in values between the newly arrived and older established residents often cause misunderstandings unless educational programs are developed in advance of the urban invasion.

At no other time has the need been greater for strong cooperative leadership in planning the future development of metropolitan areas, to the advantage of both rural and urban groups and the total socioeconomic structure of the state.

C. L. Folse, Professor of Rural Sociology, has been at the University of Illinois since 1950.

Table 2. — Illinois Population Growth and Changes Through Natural Increase and Migration, 1940-1960

Standard metropolitan statistical area	Census 1960	Census 1950	Census 1940	Change 1940 to 1960		1940 to 1950		1950 to 1960	
				Number	Percent	Natural increase[a]	Migration	Natural increase[b]	Migration
Area A[c]	150,991	133,558	113,323	37,668	33.2	11,770	8,465	19,660	−2,227
Rock Island-Moline	94,568	86,107	77,383	17,185	22.2	8,610	114	11,515	−3,054
Outside central city	56,423	47,451	35,940	20,483	57.0	3,160	8,351	8,145	827
Area B	209,765	152,385	121,178	88,587	73.1	16,355	13,852	32,942	24,338
Rockford	126,706	92,927	84,637	42,069	49.7	9,730	−1,440	16,747	17,032
Outside central city	83,059	59,458	36,541	46,518	127.3	7,625	15,292	16,295	7,306
Area C	6,220,913	5,177,868	4,569,643	1,651,270	36.1	423,320	184,905	780,883	262,162
Chicago	3,550,404	3,620,962	3,396,808	153,596	4.5	299,980	−75,826	448,712	−519,270
Outside central city	2,670,509	1,556,906	1,172,835	1,497,674	127.7	123,340	260,731	332,171	781,432
Area D	288,833	250,512	211,736	77,097	36.4	23,700	15,073	43,679	−5,358
Peoria	103,162	111,856	105,087	−1,925	−1.8	10,825	−4,056	5,562	−14,256
Outside central city	185,671	138,656	106,649	79,022	74.1	12,878	19,129	38,117	8,898
Area E	146,539	131,484	117,912	28,627	24.3	10,531	3,041	16,981	−1,926
Springfield	83,271	81,628	75,503	7,768	10.3	6,892	−767	7,895	−6,252
Outside central city	63,268	49,856	42,409	20,859	49.2	3,639	3,808	9,086	4,326
Area F[d]	487,198	388,302	316,248	170,950	54.1	35,955	36,099	73,075	25,821
East St. Louis-Belleville	118,976	115,016	104,014	14,962	14.4	11,152	−150	19,959	−15,999
Outside central city	368,222	273,286	212,234	155,988	73.5	24,803	36,249	53,116	41,820
Area G	118,257	98,853	84,693	33,564	39.6	10,179	3,981	15,966	4,338
Decatur	78,004	66,269	59,305	18,699	31.5	7,055	−91	10,946	789
Outside central city	40,253	32,584	25,388	14,865	58.6	3,124	4,072	5,020	2,649
Area H	132,436	106,100	70,578	61,858	87.6	11,862	12,418	18,904	7,432
Champaign-Urbana	76,877	62,397	37,366	39,511	105.7	6,992	18,039	13,018	1,462
Outside central city	55,559	43,703	33,212	22,347	67.3	4,870	5,621	5,886	5,970
Total SMSAs	7,754,932	6,439,062	5,605,311	2,149,621	38.3	544,675	289,076	1,002,190	313,680
Central cities	4,231,968	4,237,162	3,940,103	291,865	7.4	361,236	−64,177	534,354	−539,548
Outside central cities	3,522,964	2,201,960	1,665,208	1,857,756	111.6	183,439	353,253	467,836	853,228
State total	10,081,958	8,712,176	7,630,654	2,183,917	28.6	708,208	106,727	1,224,576	144,406

[a] Excess of births over deaths, April 1, 1940, to April 1, 1950. [b] Excess of births over deaths, April 1, 1950, to April 1, 1960. [c] Illinois portion of Davenport, Iowa, standard metropolitan statistical area. [d] Illinois portion of St. Louis, Missouri, standard metropolitan statistical area.

A PROPORTIONING ORIFICE AUGER

Can Measure Dry Grains and Feeds for Automatic Processing on the Farm

E. F. OLVER, H. B. PUCKETT, and D. R. WILSON

In recent years much attention has been given to on-the-farm processing of grains and feeds with automatic controls. More automation seems inevitable as our farms grow larger, farm labor becomes scarcer, and production increases.

With automation, time and horsepower hours can be utilized rather than sheer horsepower. That is, a small motor working steadily with automatic controls can do the job of a big motor working a short time.

At the University of Illinois much research has been devoted to processing feeds automatically with small electrical equipment. (This has been done through a cooperative development program by the Department of Agricultural Engineering and the Farm Electrification Research Branch, AERD, ARS, U. S. Department of Agriculture.)

Metering equipment essential

To process feeds and obtain the proper amount of each ingredient, accurate metering equipment is essential. As part of our research, we have developed several types of meters and tested others. One of the meters tested has been a proportioning orifice auger that meters feeds and grains by volume.

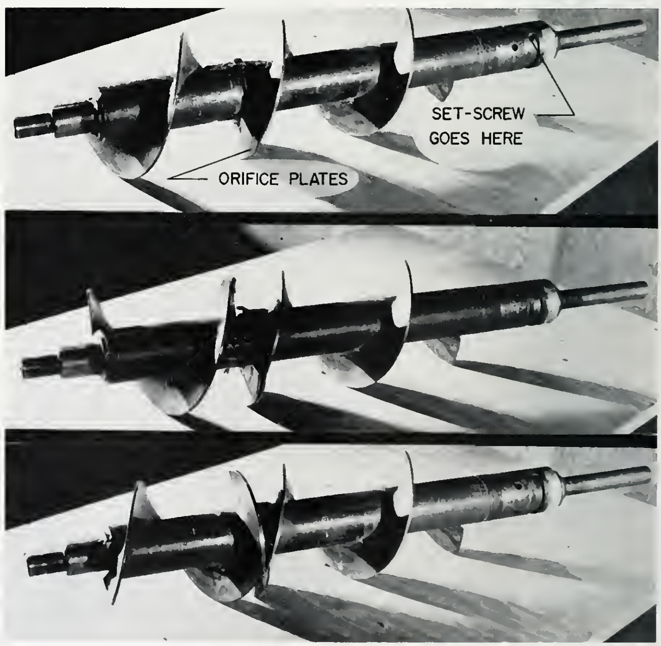
This type of meter is presently being used as a supplementary meter on self-unloading wagons. It is well suited to this purpose. However, it will not satisfactorily meter high-moisture shelled corn from storage. In recently completed tests the high-moisture shelled corn was crushed so much that it did not flow through the orifice, or opening, at a uniform rate.

Features of auger

A rotating, adjustable orifice plate is on the auger shaft. The auger is cut into two parts and the metering orifice plate into three segments (Fig. 1). A third of the orifice plate is welded to each of the two auger sections; the other third is free to rotate between the limits imposed by the two segments welded to the auger flighting. By rotating one section of the auger with respect to the other, the orifice can be varied from zero to 66 percent open.

Once the opening of the auger is adjusted, a set screw holds the two sections in place. (In the right part of Figure 1, one can see where the

Three views of the proportioning auger. The top view shows the unit operating as a regular auger at full capacity. In the lower view the auger is completely closed so that no material can pass through the opening, and the delivery is zero. In the middle view the auger unit is approximately half open. (Fig. 1)



set screw goes.) The particular auger meter that we tested was graduated from 1 to 20; however, for all practical purposes, only settings 3 to 19 were useful.

Varying the opening permits reasonably accurate metering of ground feed and dry grains with constant auger speed. Output of the meter is controlled by size of opening and speed of rotation.

It is essential that the auger meter itself be located inside the bin and that the orifice disk be just inside the auger casing where the feed or grain leaves the bin. The input portion of the auger is always filled with material. This input portion should be kept short to reduce the power requirements of the meter.

In the tests reported here, an 8-foot-high bin was constructed above the auger meter to show its operation when under the head pressure of a great depth of grain or feed.

This is the test apparatus with the proportioning orifice auger in action. The feed dropped from the auger into the collection chamber in the foreground and was immediately taken back into the auger bin so that any length test could be run. (Fig. 2)

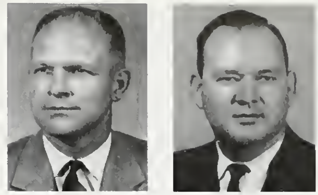
Feeds tested

The dry feeds that were successfully tested with this unit were soybean oil meal, oats, shelled corn, and ground feed. The ground feed consisted mainly of fine ground corn and soybean oil meal. In Figure 2, dry feed can be seen issuing from the meter in one of the tests.

Soybean oil meal was tested first since it would not compact during the test. In general, it would change less in physical form and characteristics than would the other three feeds.

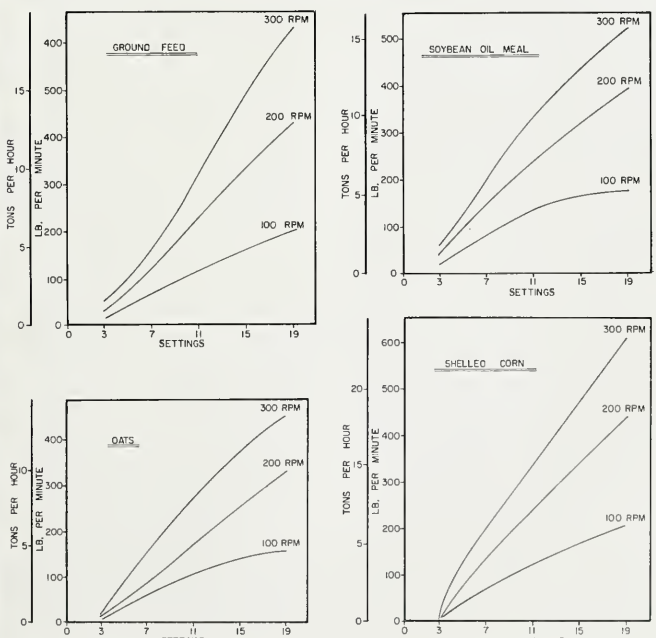
Figure 3 shows in graphical form the results for the four feeds with orifice settings varying from 3 to 19 and with three auger speeds — 100, 200, and 300 revolutions per minute. As can be seen from these charts, the data fell on smooth curves.

The proportioning auger offers a reasonably accurate method of metering a variety of dry grains and feeds. The meter can operate from 0 flow to 18 tons an hour at 300 revolutions per minute.



E. F. Olver (left) is Associate Professor of Agricultural Engineering. H. B. Puckett (right) is Agricultural Engineer, Farm Electrification Branch, AERD, U. S. Department of Agriculture, stationed at the University of Illinois. This report is based partly upon work done by D. R. Wilson, a former student in agricultural engineering, as his senior research problem.

Capacity of the proportioning orifice auger using a ground feed, soybean oil meal, oats, and shelled corn. (Fig. 3)



The College Invites You to an Open House

K. A. KENDALL

Visitors are always welcome at the College of Agriculture. But our doors will be opened especially wide on September 7 and 8 for a new kind of open house, the Farm and Home Science Show.

This year we will take you right out to our farms to show you up-to-the-minute research in action and a lot of results. Special exhibits and demonstrations will explain this most modern research as well as point up the progress which has been made during the 100 years since President Lincoln signed the Land Grant Act.

Agriculture tours

Shuttle buses will take you to the exhibit areas from several parking lots. The following paragraphs tell some of the demonstrations to be featured at each display area.

Animal Center, at the Beef Barns. Pens of live animals will show the results obtained with modern feeding and management methods and results obtained with the methods of 100 years ago. Some of the automatic feed-handling equipment used at the beef barn will be demonstrated. Latest methods of controlling animal diseases and insects will be featured. Exhibits will emphasize modern procedures in veterinary medicine and give a glimpse of procedures of the past. You'll agree much progress has been made.

Agronomy South Farm. Here you will see plots where research has been done on corn genetics, corn diseases, corn fertilization, field ventilation, soybean varieties and diseases, current insect problems, alfalfa varieties, and forage species and mixtures. A farm building constructed of precast concrete rigid frames will be on display. Among other things to see in this area will be a mechanized exhibit that Agricultural Economics has developed to show how farm income is affected by changes in production or marketing costs, market development, and production adjustments.

Special exhibits will show major research accomplishments of the College of Agriculture, the work of the Cooperative Extension Service, and the development of vocational agriculture in Illinois high schools. A film, "The College of Agriculture From the Student's Viewpoint," will be shown every 30 minutes, and information for prospective students will be presented.

Lincoln Avenue Dairy Barns. Exhibits will show progress in dairy science during the past century; and you will see a replica of an old-time dairy setup, as well as the most modern lactorium.

Illini Forestry Plantation, South Race St. A mobile field laboratory will be set up here to demonstrate basic forestry research on light reflectance from tree leaves. Results of current research on use of chemical herbicides in tree plantations, and methods and advantages of pruning coniferous plantations will also be shown.

Horticultural Field Laboratory and Farm. Guided tours of the food-processing laboratory are scheduled, and modern methods of processing sweet corn will be demonstrated.

Bean and tomato plots treated with the most modern chemicals can be compared with others left uncared for in the manner of 100 years ago. A tomato harvester will be displayed, as well as new tomato varieties adapted to mechanical harvesting.

Agricultural Engineering Farm, South Race St. Corn and soybean plots will show the results of different tillage methods. Among machines on display will be special corn-harvesting machinery, experimental equipment for highway roadside maintenance, a plastic-mulch layer and seeder, and tile-laying trenchers.

Home economics

A speaking program — including talks on foods and on home furnishings — has been scheduled for 10:00 to 11:30 both Friday and Saturday mornings in Bevier Hall auditorium.

Afternoon programs will be held from 1:30 to 3:00 in Lincoln Hall Theatre. Features will be a panel discussion on the education of women and a showing of costumes of the past century.

A number of classrooms and laboratories in Bevier Hall will be open to visitors, to show some of the teaching and research being done in home economics. Exhibits in 282 Bevier Hall will typify the Extension programs in the counties.

The Departments of Home Economics and of Horticulture will cooperate in a tour of the flower gardens.

Art and recreation

The Town and Country Art Show, in the gallery of the Architecture Building, will feature the work of amateur Illinois artists. It will be open from 9:00 a.m. to 9:00 p.m. on September 7 and from 9:00 a.m. to 3:00 p.m. on September 8.

A centennial photography exhibit by the U. S. Department of Agriculture will depict "The Changing Faces of the Land." This extraordinary exhibit will be set up in the Stock Pavilion. Rural recreation resources will also be featured there.

Food and lodging

Snacks and soft drinks will be sold at the Agronomy Farm, the Agricultural Engineering Farm, and the Stock Pavilion both days of the show. Regular food service will be available in the Illini Union.

If you are planning to stay overnight in a hotel or motel, advance reservations are advisable. A list of accommodations in private homes is available from the University Housing Division, 108 Illini Hall.

K. A. Kendall, Professor of Dairy Science, is general chairman for the show.

RESEARCH IN BRIEF

A New Procedure for Diagnosing Hog Cholera

The recent emphasis on eradication of hog cholera has caused regulatory officials and research workers to focus attention on the problem of diagnosing this condition. Although a correct diagnosis can usually be made on the basis of clinical signs, case history, and gross and microscopic lesions, it is not uncommon to encounter atypical or complicated cases where an objective diagnostic test would be of great value. Such a diagnostic test has been developed at the College of Veterinary Medicine and is now being refined and evaluated.

For this test, a suspension of rabbit erythrocytes (red blood cells) is treated with formaldehyde to make the cells extremely hardy. Through a stable diazo linkage, the erythrocytes are combined with hog cholera antibodies, obtained from the serum of an immunized swine. The resultant suspension of antibody-coated erythrocytes is then mixed in test tubes with the material suspected of containing hog cholera virus. If virus is present, it combines with the specific antibodies on the surface of the erythrocytes. One can see the erythrocytes clumping together to form a lattice work. Thus a specific serologic reaction, the combination of hog cholera virus with its antibody, is visible to the unaided eye.

This new procedure, which has been called the hemagglutination or HA test, has detected hog cholera viruses in the blood of experimentally infected swine as early as 48 hours after exposure. At that time fever and other signs of illness have not yet appeared. Virus was also detected in extracts of spleen from swine dead of the disease.

The HA test should prove valuable in hog cholera research as well as in diagnosis. For example, hog cholera virus is known to propagate in tissue cultures, but, unlike other viruses, it does not destroy the cells in which it grows. Under these conditions, tissue culture methods are of little research value, because the presence of the virus in the cultures must be confirmed by inoculation of susceptible swine. This difficulty would be overcome by an alternate method of detecting virus in tissue cultures. The HA test gives promise of accomplishing this.

Although the HA test has given encouraging results, the procedure must be improved and refined before it can be used for routine diagnosis. It is expected that testing on a relatively large scale will provide the information needed for evaluating this method. — *D. Segre*

A Potential Disease Threat to Illinois Cattle

Johnes disease has been diagnosed with increasing frequency in Illinois beef and dairy cattle during the past year.

Otherwise known as paratuberculosis, the disease is caused by *Mycobacterium paratuberculosis,* a relative of the agent causing human and bovine tuberculosis. The clinical disease is characterized by a profuse diarrhea, emaciation, dehydration, and a progressive downhill course ending in death.

The characteristic gross pathologic finding described in textbooks — namely a thickening or corrugating effect of the lower digestive tract — has not been observed in eight animals necropsied at the Illinois Diagnostic Laboratory. The diagnosis was established by using Ziehl-Nielsen acid-fast staining techniques on areas of intestinal tract taken from the ileo-cecal valve and its draining mesenteric lymph nodes.

The disease can be diagnosed with reasonable certainty by the intradermal test, utilizing johnin or avian tuberculin. In limited field studies of 320 cattle in two beef herds and one dairy herd, 35 percent of the cattle had a skin reaction to either johnin or avian tuberculin. Nearly 10 percent of these reactors also had a positive reaction to mammalian tuberculin.

As a result of this preliminary work and other clinical reports, it is believed that Johnes disease poses a serious threat to both beef and dairy cattle in Illinois. — *R. L. Brewer and J. Simon*

Ascorbic Acid Content and Palatability of Green Peppers Frozen in Different Ways

Published directions for the preparation of sweet green peppers for freezing vary. Recommendations include freezing peppers after blanching or without blanching, and packing dry or with added brine. Since data were not available on the ascorbic acid content and palatability of peppers given these different treatments, a study was undertaken to provide the information.

Peppers of the Allbig variety were prepared for freezing in four ways. Each variation was repeated on three different days in each of two years. Halves of peppers were frozen the first year, and quarters, the second year.

To blanch peppers, 1200 grams of halves or quarters were added to 10 quarts of boiling water and heated for 2 minutes. Then the blanched peppers were cooled in cold running water for 3 minutes. One lot of blanched peppers and one of unblanched were packed as tightly as possible in quart-size polyethylene bags. Two other lots, one blanched and one unblanched, were put in quart-size rigid plastic containers and covered with 2 percent brine.

Reduced ascorbic acid was determined in raw peppers and in all samples after 4 and 8 months of freezer storage. After these intervals of storage, peppers packed without brine were thawed and rated by a

taste panel, and samples of all treatments were cooked and rated.

After thawing, the plain-packed blanched and unblanched peppers were bright green but lacked crispness and had a strong flavor. The taste panel rated them fair to high fair in acceptability, mean scores ranging from 3.4 to 3.7. (The minimum score on the scale was 1, or very poor; the maximum, 5, or very good.)

Mean values for ascorbic acid content and for acceptability scores of cooked peppers are given below:

Treatment	*Mo. of storage*	*Mg. of ascorbic acid per gm.*[a]	*Acceptability scores*[a]
Raw, fresh.....	0	1.45±.040	
Plain pack			
Blanched....	4	1.32±.089	3.7±.07
	8	1.18±.076	3.4±.10
Unblanched.	4	1.37±.093	3.6±.09
	8	1.19±.079	3.2±.10
Brine pack			
Blanched....	4	0.62±.063	3.5±.09
	8	0.60±.070	3.0±.10
Unblanched.	4	0.77±.049	3.0±.11
	8	0.79±.081	2.9±.10

[a] Means of 6 replications and standard deviations of the means.

Cooked frozen peppers were considered acceptable but not good by the taste panel. Although the plain-packed blanched peppers received slightly higher scores than the others, the differences were not large enough to be of practical importance. Peppers frozen in brine were a dull olive-green.

Packing in brine significantly reduced the amount of ascorbic acid. After 4 months of storage the blanched and unblanched peppers which were packed plain retained 86 and 94 percent of the original ascorbic acid content, while those packed in brine retained only 31 and 43 percent, respectively.

From the standpoint of convenience in handling both before and after storage, the dry pack is preferable to the brine pack. Plain-packed peppers were slightly preferred by the judges, and also retained significantly larger amounts of ascorbic acid. Blanching had comparatively little effect on quality. — *Frances O. Van Duyne*

Sterilized Milk and Milk Products Are Expanding

Sterilized milk products have developed rather rapidly during the past two years. At the end of 1961 there were 55 installations of aseptic canning equipment, most of them used in processing dairy or dairy-type products. Half of these installations were made in 1960 and 1961. It is expected that 24 new aseptic canning lines will have been installed by the end of 1962.

Products processed by aseptic canning are dietary foods, whole and concentrated sterilized milk, flavored milks, and sterilized cream. Tins range from ½ pint to 3 quarts in size. One company packages half pints in Tetra-Pak while another company packages half pints in glass.

Dietary foods accounted for the principal expansion in sterilized products in 1961. Expansion has continued in the canning of sterilized whole milk. One firm which has been marketing sterilized dairy products since 1941 is now using 70,000 gallons of milk daily for sterilized cream, dietary foods, baby foods, and sterilized whole milk. This firm sells its products in 46 states. Eighty-five percent of all its products are sold through regular commercial channels.

Another company is selling sterilized cream packaged in half-pint and quart tins in over 300 stores. This company has nationwide coverage in the sale of low-heat nonfat dried milk to grocery stores and is planning to gradually extend its sales of canned cream to these same stores. Other companies are planning to sell sterilized milk products, including sterilized concentrated milk, on the commercial market in 1962. — *R. W. Bartlett*

The Role of Vitamin E in Animal Diets

Because female rats do not produce young when they are fed vitamin E-deficient diets, vitamin E has long been regarded as an antisterility vitamin. However, other species fed diets lacking vitamin E develop quite different symptoms. In the chick, vitamin E deficiency leads to specific abnormalities in the nervous and vascular system; in the rabbit and the lamb, muscular weakness resembling muscular dystrophy in man; and in monkeys, muscular weakness and anemia.

Despite these well-known facts, no specific biochemical function of vitamin E in animals has been elucidated. So far very little information has been obtained which would provide clues as to the role it serves in the prevention of the disorders described above. Experiments in the Division of Animal Nutrition during the past few years have strongly supported the view that vitamin E serves to prevent the peroxidation of unsaturated fats in the animal's tissues.

Data have been obtained to show that synthetic antioxidants are capable of supporting pregnancy in female rats fed vitamin E-free rations and that the characteristic deficiency symptoms seen in chicks can likewise be prevented if their diets contain a suitable synthetic antioxidant. Current studies are aimed toward developing a clearer understanding of the fate of vitamin E in the body. It is possible that one of the products resulting from the metabolism of vitamin E in tissue serves as an active compound. Further research is necessary to provide the answers. — *J. Kastelic*

Textile Fatigue

Many of the textile-testing procedures in use today are designed to make a fabric fail rapidly (for example, by causing a break within 20 seconds or by rubbing until a hole is formed).

Such testing procedures are valuable tools for controlling fabric quality in a textile mill or for measuring the changes in a fabric's properties caused by a research procedure. However, they give us little information to explain what happens to a fabric in actual use. Here fabrics

are stretched slightly — then allowed to recover; rubbed against another fabric or a hard surface — then allowed to recover; or bent or wrinkled — then allowed to recover. These processes are repeated many, many times before a fabric loses its ability to retain its original shape or becomes "fatigued."

One of the textile research projects now being conducted by the Department of Home Economics is concerned with the fatigue of textiles caused by repeated stretching or abrasion at levels much lower than those needed to cause fabric failure. After being stressed, the fabrics are tested for changes in weight, thickness, stiffness, wrinkle recovery and strength, and elongation. Yarns and fibers from the fabrics are examined to try to find explanations for the changes in fabric properties. — *Ruth Galbraith*

Jonathan Baldwin Turner: Early Advocate of the Osageorange Hedge

Almost as soon as Jonathan Baldwin Turner arrived in Illinois in 1833, he began his search for a species to form a living fence on the prairies. For he saw that a shortage of suitable fencing materials was hindering the development of the fertile prairie soils. The successful conclusion of his research in 1847 and his vigorous promotion of the osageorange (*Maclura pomifera*) earned for him the title: "Father of the osageorange hedge."

Turner first experimented with barberry, boxwood, and hawthorn, species used for hedges in Europe, but these failed because of the hot, dry summers. While seeking a more adaptable species, he discussed his hedging experiments with the Reverend Dr. David Nelson, a traveling preacher, after a camp meeting. Nelson suggested osageorange, which he had seen during his travels in Arkansas.

After 10 years of research with this small, thorny tree, Turner published a circular describing its hardiness and suitability for hedging, and offered plants for sale. In the next 30 years many miles of hedges were planted. Although they were not always successful as fences, largely because of poor management, there can be no question that osageorange served a useful purpose in the development of the prairies. The hedges provided the best solution to the problem of fencing for about 30 years before barbed wire came onto the market. Even in their removal they continued to serve, providing durable posts for the barbed wire fences that replaced them. — *Duncan A. Harkin*

Osageorange hedge — a vanishing reminder of one step in the development of prairie agriculture.

Changes in Labor Requirements for Corn Production

Man labor needed to produce an acre of corn has decreased nearly 70 percent in the past 40 years. This change is shown by figures from detailed cost-account studies in central Illinois. In 1921-22 in Champaign and Piatt counties, it took 14.4 hours of man labor to grow and harvest an acre of corn; in 1959-60, only 4.7 man hours.

Changes in the methods of growing and harvesting are responsible for the decreases in labor used per acre. From 1920 through the 1940's, the reduction in hours of labor was associated with the change from horse to mechanical power for field implements and with the adoption of mechanical field-harvesting machines.

Much of the time-reducing possibilities of mechanical power and field-harvesting machines had been realized by the 1940's. The more recent reduction in labor and tractor hours has been due to an increase in tractor power, the use of larger power-drawn machinery in multiple or individual units, and shifts toward reduced tillage practices.

At the same time that man hours per acre were being reduced, yields per acre were increasing. On record-keeping farms, corn yields increased from 48.8 bushels per acre in 1921-22 to 88.8 in 1959-60. This increase in yield reduced even further the time spent per bushel in growing corn.

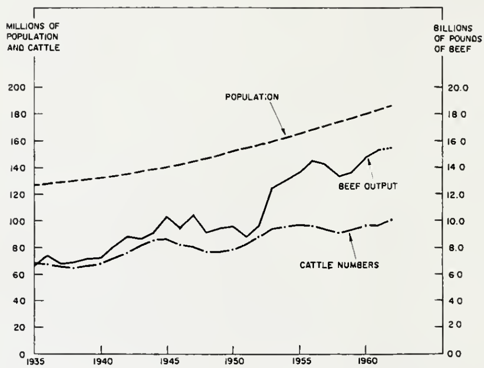
Today only one-third as many hours are required to produce an *acre* of corn as were required 40 years ago, but only one-fifth as much time is required to produce a *bushel* of corn. — *R. A. Hinton*

FARM BUSINESS TRENDS

BEEF PRODUCTION is one of our nation's greatest industries, with an output valued at $9 billion a year. Some of the important trends in this industry are shown in the chart. One outstanding fact is that beef output has increased much more than population over the past 20 years, yet prices of cattle have held up much better than prices of most other farm products.

The chart also shows most of the last three cycles in cattle numbers. These cycles are an important feature of the beef-cattle industry in the United States.

The latest uptrend in cattle numbers began in 1958. It has thus been underway for four years. Fortunately for almost everybody concerned, this increase in numbers has been unusually slow — only 9 percent in the four years. This is much less than in comparable previous periods. For example, cattle numbers jumped 23 percent in 1949-1953, and 19 percent in 1938-1942.



While the increase in cattle numbers was slow, the increase in beef output was immediate and substantial. It went up from 13.6 billion pounds in 1959, to 15.5 billion pounds in 1961. This increase was taken by consumers without excessive price reductions.

While no great increase in beef production is in sight, cattle slaughter will probably increase moderately, beginning later this year or in 1963. This increase is expected because:

1. We began this year with 2 million more cattle than last year.

2. The 1962 calf crop is expected to be up about a million head, or 2½ percent.

There will, however, be some offsetting factors:

1. Average carcass weights usually decrease as slaughter increases.

2. Imports of beef, which made up 6 percent of our supply in 1961, are expected to decrease.

3. Population growth is about 1⅔ percent a year.

The prospective increase in beef supplies over the next few years may thus be absorbed with only a moderate reduction in cattle prices. — *L. H. Simerl, Professor of Agricultural Economics*

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Fall, 1962

ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

IN THIS ISSUE

A stop at the famous Morrow plots was on the program for visitors at the 1962 Farm and Home Science Show (page 2).

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ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

CONTENTS

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Louis B. Howard ....Dean and Director

M. B. Russell..............Associate Director

Adrian Jones..................Station Editor

Margery E. Suhre....Editor, Illinois Research

THE 1962 FARM AND HOME SCIENCE SHOW, held on the University campus September 7 and 8, was an all-out effort to let visitors see representative work from every department of the College of Agriculture.

Many exhibit areas were on the University farms. Staff members explained the research being conducted at some of the experimental plots and livestock barns, and also demonstrated new equipment and machinery. Special exhibits and displays were set up in tents on the farms and also in campus buildings.

Emphasis was on the current work of the College, but some of the exhibits compared our present-day knowledge and methods with those of 1862, the year that the Land-Grant act was signed. The whole show was a reminder that one of the big changes during the past century has been in the scope and complexity of agricultural research itself. New knowledge and new discoveries continually open up further fields of investigation.

It was to describe and explain some of the investigations now being carried on that Illinois Research was begun. During this year of the Land-Grant centennial, and particularly in the present issue, we have interspersed our accounts of current research with reminders of the past. For it is important to remember that the work of today would not be possible without the achievements of yesterday.

The Illinois Agricultural Experiment Station Since the Hatch Act

As we observe the Land-Grant centennial, we also celebrate the 75th anniversary of the act which established the agricultural experiment stations

D. A. BROWN

On March 2, 1887, President Grover Cleveland signed into law an act to establish agricultural experiment stations at Land-Grant colleges. This was the culmination of 16 years of effort which began August 24, 1871, in Chicago when Regent John M. Gregory of the Illinois Industrial University (now the University of Illinois) organized a committee of representatives from 28 other Land-Grant colleges to explore ways and means of securing federal funds for research stations.

Supporters of the experiment stations proposal found a willing ally in Missouri Congressman William H. Hatch, who was also publisher and editor of *Colman's Rural World* (St. Louis) and a leading exponent of agricultural education. As chairman of the House Committee on Agriculture in 1885, Hatch asked the Land-Grant colleges to assist him in drawing up a bill, and thus the Hatch Act came into being.

One week after the Hatch Act became law, Regent Gregory's successor, Selim H. Peabody, advised the Board of Trustees of the University of Illinois that "an important duty and a large responsibility will rest upon this University in carrying out the details imposed by this act. I suggest that the subject be referred to a committee which shall have authority to take steps to secure the necessary legislative sanction, required by the act itself, which committee shall also be charged with the duty of presenting at a subsequent meeting a plan for the organization and conduct of the experiment station contemplated in connection with our University."

The trustees considered the new experiment station of such importance that they appointed Regent Peabody its committee chairman, and at a meeting later in the year adopted a recommendation that the station "be deemed a department of the University." On April 1, 1888, after being approved by the state legislature, the Illinois Agricultural Experiment Station began operations.

Early years

Eight men, or the entire College of Agriculture, made up the staff of the new Experiment Station. Three of them had been conducting experiments for several years — George E. Morrow on the plots which he started in 1876, Thomas J. Burrill with bacteria and plant diseases, Thomas F. Hunt with animal feeding. Their work had been severely restricted, however, for lack of adequate laboratory equipment and assistants to help with the routine tasks which accompany all research. Now with an annual appropriation from the Hatch Act of $15,000 — a considerable sum in 1888 — George Morrow and his colleagues could seek new knowledge, could try to solve some of the many problems confronting Illinois agriculture in the late nineteenth century.

Space on the upper floor of the Chemistry Building was assigned to the Station for offices and laboratories. The Station budget included

Two-thirds of the Experiment Station staff in 1898. In left row, top to bottom, are T. J. Burrill, Horticulturist and Botanist; Donald McIntosh, Consulting Veterinarian; J. C. Blair, Assistant Horticulturist. In right row are Eugene Davenport, Agriculturist and Director; P. G. Holden, Assistant Agriculturist; W. J. Fraser, Assistant in Dairying. Also on the staff were Cyril G. Hopkins, Chemist (picture on next page); Stephen A. Forbes, Consulting Entomologist; George P. Clinton, Assistant Botanist.

$3,000 for books and periodicals, $2,700 for laboratory equipment, $2,175 for salaries, $100 for a typewriter. By the end of the first biennium of operation, the Station had undertaken more than a hundred

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D. A. Brown, Agriculture Librarian and Associate Professor of Library Administration, is the author of several books about the West and American history.

experiments on field crops, livestock feeding, dairying, and horticulture, and in the same period had reported results of completed work through the publication of eleven bulletins.

The early growth and development of the Experiment Station served to invigorate the Illinois College of Agriculture, which in the 1890's was virtually moribund, with numbers of students steadily declining. The rejuvenation of the college did not occur overnight, but year after year as the Station moved ahead with its investigations, it won the respect of farmers who previously had scorned the idea of sending their sons "to learn plowing from a set of scientific professors."

Linking teaching with experiments, the college made its courses more comprehensive and attractive, and was able to demonstrate George Morrow's proposition that agricultural science was not learning *how* to plow but the *reasons* for plowing, "to understand thoroughly all that man can know about soils and seeds, plants and animals, and the influences of light, heat and moisture on his fields, his crops and his stock."

Expansion begins

By 1895, when Eugene Davenport took over direction of the College and Station, the more progressive Illinois farmers were strong supporters of new programs for advancing agricultural science through education and research. Davenport proved himself to be a dynamic leader, and under his direction Illinois was soon in the vanguard of agricultural experimentation.

More trial plots were opened on the South Farm; 40 experimental fields were started in different parts of the state so that all types of Illinois soils would be represented in crop tests. In 1902 the Soil Survey began its county soil mapping of the state.

In 1905 Cyril G. Hopkins began developing his famed system of permanent soil fertility for Illinois; he brought carload shipments of rock phosphate and limestone to Urbana and applied them on the Experiment Station fields. To test his theories he purchased a worthless tract of land in Marion county and called it Poorland Farm; on the acreage where he applied limestone and phosphate he was soon quadrupling yields. After years of patient experimentation Hopkins was able to show Illinois farmers how they could multiply their profits per acre through use of scientifically applied fertilizers and a crop rotation program which included legumes.

In the first quarter of this century, Illinois led the world in corn breeding experiments, discovered that the composition of corn could be changed by breeding, pioneered in developing corn hybrids and new soybean and wheat varieties, and proved that shallow cultivation of corn would produce more bushels per acre than deep cultivation.

During this period some of the first experiments in animal nutrition also originated at Illinois. Under H. W. Mumford's direction, the station developed the first comprehensive animal husbandry research program in the nation, training specialists for each class of livestock. In beef cattle research, Illinois was the first to use carload lots of animals in feeding experiments, making possible more valid results. After lengthy investigations at Chicago livestock markets, Illinois pioneered in standardizing classes and grades of livestock. The Meats Laboratory devised methods to measure meat toughness, and proved that the tougher the meat the less nutritious it was.

Horticultural researchers discovered the cause of bitter rot and demonstrated that it could be prevented by spraying with Bordeaux mixture. Plant breeders introduced new varieties of apples and peaches. In the model dairy plant a new method of condensing buttermilk was discovered and soon adopted by the industry.

Dairy scientists developed the first cows in the state to produce over a thousand pounds of butter in a year. Illini Nellie, the famed Brown Swiss, set world records for milk and butterfat production. In the 1930's she received more publicity than any person connected with the University, articles appearing in magazines and newspapers all over the world, and after she died a poem was composed in her memory.

Cyril G. Hopkins in one of the experimental corn plots about 1912.

Out of the breeding and feeding programs of the Station's purebred livestock herds came valuable information on nutrition requirements, digestibility, vitamins, food poisoning, immunity, barn construction, and feeding equipment, the principles of which were applicable not only to agriculture but to other areas of science and engineering.

Many of the early discoveries of the Illinois Agricultural Experiment Station have been superseded by later findings. Others have become such familiar everyday farm practices that most of us tend to forget that no one was aware of them until years of experimentation had proved their practicability.

Economic value

Measuring new additions to human knowledge by the dollar sign is almost as futile as attempting to measure the value of a human being. Yet research costs money, and administrators of research have from time to time tried to justify

The campus as it appeared in 1914 from a window in University Hall.

their expenditures by measuring returns on the investment. For example, in 1908 Davenport estimated that the value of the Illinois corn crop was increasing at an average of $20,000,000 per year as a result of discoveries made at the Experiment Station: actually this proved to be an underestimate over the next 10-year period. Hopkins proved that his permanent soil fertility program would increase monetary returns by $20 to $40 per acre. H. W. Mumford established a feeding program which added $8 to the value of each Illinois steer.

These early estimates seem small when compared to returns from agricultural research of more recent years. In 1950 a national magazine estimated that crop rotation discoveries at Illinois were worth $100,000,000 a year to farmers of the state. Research leading to solution of the cause of alfalfa failure on Illinois soils was valued at $32,000,000 annually; dairy cattle feeding programs, $30,000,000 annually; swine hygiene investigations, $1,000,000 annually. "As a result of the University's research," the publication stated, "the farmers of Illinois are making more money each year than the state has spent on the school since its founding in 1868."

Farm profits from soybeans in Illinois have risen astronomically since 1914, when the Experiment Station began urging farmers to grow this ancient Oriental plant. At first not many were interested, but the missionary fervor of William L. Burlison soon convinced crop growers that soybeans were no passing fad but a real money crop. From 15,000 bushels in 1914 to 125,000,000 in 1961 is rather impressive proof that Burlison was right.

Farmers' support

From its beginnings the Station has worked in close cooperation with farmers of the state. Regent Gregory's most loyal supporter in the drive to obtain funds for an experiment station at Illinois was Willard C. Flagg, a fruit grower and cattle raiser of Madison County. With as much enthusiasm as his friend, Jonathan B. Turner, had advocated Land-Grant colleges, Flagg campaigned for a national system of agricultural experiment stations.

After the Urbana Station was started, an advisory board of farmers and livestock breeders met regularly with the directors, and the support and advice of agricultural leaders such as H. M. Dunlap, E. E. Chester, Ralph Allen, Frank I. Mann, Joseph Fulkerson and many others contributed to the rapid advance of research at Illinois.

When it became evident around the turn of the century that Hatch Act funds were insufficient for all the research which needed to be done, local farmer organizations spurred the state legislature into contributing state funds. In 1902 the legislature more than tripled the Hatch Act allotment. Today the state of Illinois is still tripling federal funds available to the Station.

Research is cooperative

During the past quarter century, scientific research has become much more complex than it was in the first years of Hatch Act appropriations. As agriculture has grown more technical and specialized, scientists have also tended toward specialization; thus the contributions of many scientists working in different areas are often necessary before a problem can be solved. A vast amount of basic research must be kept in progress to insure a continuing pool of knowledge available to all branches of agriculture.

Science has never recognized man's artificial geographical boundaries. What is discovered at Illinois may be applied in other states or nations, and discoveries made elsewhere may be adopted or modified for Illinois farmers.

Illinois has been a leader in cooperation with other experiment stations, particularly in the North Central region. Time and money have been saved through cooperative projects in such areas as land tenure, marketing, rural sociology, and farm management.

Some recent contributions

In recent years the Illinois Station has had to adjust rapidly to the agricultural revolution it helped to create. Electronic computers and such modern research methods as linear programming are helping research workers to solve many more problems than in the past.

One of the major assets available to Illinois agricultural economists is the mass of farm cost studies collected over the past half century. Thanks to cooperating farmers who supplied the detailed information, the Station has the basic data for analyzing and predicting costs and returns of various types of farm enterprises. Agricultural economists

at Illinois have also pioneered in developing modern techniques of land appraisal, establishing standards, and holding conferences and conducting clinics in various counties of the state.

For years Illinois agricultural engineers have been showing the way toward increased automation of farm operations formerly requiring many hours of labor. Improved methods of grain conveying, feed mixing, and materials handling are under constant demonstration. A recent important engineering contribution is a system of automatic feed handling and waste disposal for the confinement raising of swine.

A basic addition to man's knowledge of the role of amino acids in nutrition was made recently by Illinois animal scientists, who formulated a chemically defined diet which supports chick growth as well as diets containing natural feed ingredients. Another significant advance was the development of the technique of hypophysectomy (surgical removal of the pituitary gland) of chicks, which makes it possible for scientists to analyze the hormonal control of the laying cycle of hens. New progress has also been made in creating disease resistance and improving fertility in poultry and swine through genetic selection.

Horticulturists at the Station are currently developing apple varieties resistant to apple scab. Through intensive studies of chemical and physical changes in fruits, new knowledge is now available which will make it possible to improve standards at maturity. For some years the Station has pioneered in the development of tests to evaluate genetic potentials of vegetable plants. Discoveries have been made in soil and fertilizer relationships, which should prove of great value to vegetable growers.

Floriculturists at Illinois have led the world in creating new chrysanthemum varieties; they have proved the usefulness of steam sterilization of greenhouse soil, established new standards for planting and feeding greenhouse roses, developed new stocks of disease-free carnations, and proved that photoperiodism can be used to advantage in the propagation of carnations.

Forestry investigations over a period of years have proved the adaptability of several tree species to various areas of the state. Research on growth and marketing of Christmas trees has opened new sources of income to many Illinois landowners. New methods of preserving wood, tests of hybrid pines, control of forest-tree insects, and development of a chemical formulation for burning tree stumps are other recent significant contributions from forestry researchers.

Since the pioneering days of Isabel Bevier, home economists at the Illinois Station have been making outstanding contributions to the improvement of home living — physically, aesthetically, and culturally. Recent research has brought new knowledge on the mineral, protein, thiamine, and riboflavin requirements of human beings, and the effects of dietary interrelationships and food sources on nutrient requirements. Illinois home economists have taken the lead in researching space requirements for work areas in homes, and in designing efficient and pleasing work and living areas.

For many years the Experiment Station has cooperated with the State Natural History Survey, particularly in the field of insect control. One of the important contributions from the entomologists is a practical method of controlling soil-inhabiting insects which attack roots of corn plants. Illinois entomologists are continually studying chemicals used in insect control to assure that they will not endanger the health of man. Basic research now under way should lead to increasing use of microbial and other biologic agents in the control of insects and perhaps less dependency upon chemicals.

Direct human benefits

Increasingly as the boundaries of science tend to intersect, more and more discoveries by Illinois' agricultural scientists have direct benefits for human beings. Chloromycetin, endomycin, filipin, tetrin, and other important antibiotics were discovered by plant pathologists. Out of the basic research of food technologists has come information vital to understanding the causes of heart diseases. Veterinary scientists at Illinois now have a new laboratory for studying rabies, tuberculosis, undulant fever, and other diseases communicable to man by animals.

In the 75 years since the passage of the Hatch Act, agricultural research has gone far beyond the dreams of the men who conceived the first experiment stations. Each quarter century, in fact, has seen an almost complete revolution in agricultural techniques. Based in the heart of America's richest farmlands, the Illinois Agricultural Experiment Station expects to continue as a leading participant in the dynamic changes of the next 25 years.

Illini Nellie, a famous personality of the 1930's, with one day's production of milk and the butter that could have been made from the fat in the milk. While she lived she was the world's greatest producing cow of the Brown Swiss breed.

Jonathan Baldwin Turner, Horticulturist

C. J. BIRKELAND

A MAN of many talents, Jonathan Baldwin Turner is now remembered primarily as the father of the Land-Grant college system and as a Professor of Classics at Illinois College in Jacksonville.

He is also remembered for promoting the osage orange as a fence for prairie farms and for originating the Turner red raspberry, which for years was the standard variety in this and many other countries.

An enthusiastic amateur horticulturist, he at one time had a greater collection of plant materials than did the Smithsonian Gardens in Washington. Included in the collection were evergreen seeds from all parts of the world.

Although he lectured about his research to many organizations, this report is limited to papers given before the Illinois State Horticultural Society. He was elected an honorary member of the society in 1856, and, beginning in 1871, served three terms as president of the Jacksonville Society.

A range of horticultural interests

The range of Turner's interests is indicated by the many papers he presented at the annual meeting of the Horticultural Society in 1858.

In one long and scholarly paper, he recommended subsoiling or deep tillage, and dealt with implements used, power, and effects of plowing on the soil.

Another paper advocated that trees be planted to shelter the house, orchard, and farm buildings from cold winter winds. White pine, red cedar, hemlock, American black spruce, and osage orange were the trees he recommended. He also recommended lime, dry ashes, and tobacco juice for insect control.

He discussed strawberry varieties and culture, and also recommended selecting wild blackberries for size and superior flavor, describing two distinct kinds he selected from woods near Jacksonville some years earlier. Recommending and describing the Orange apple variety, he offered to furnish scions free.

In addition to all this, Turner was appointed to a committee to recommend a list of hardy shrubs and evergreens for the home grounds, including range, prices, and proper planting and cultivating methods.

Work with pear blight

One other important topic — pear blight — was discussed by Turner at the 1858 meeting, 20 years before T. J. Burrill discovered the cause of this disease.

"I have paid much attention to pear culture for the last 15 years," said Turner. "The result of my observations has led me to believe that blight is caused either by fungus or fermentation of the sap. The proximate cause may be an insect, described by me, some years since, in *The Horticulturist*. It can be killed, as can all insects injurious to trees, by spirits of turpentine. If the spores of fungus are in the air from trees in the vicinity, they will take blight as if by contagion."

In 1878 he reported, "I found that this disease is exceedingly contagious; for if I used my knife to prune a healthy tree after having used it in shaving the diseased one I communicated the disease to that tree; so I soon learned to dip my knife in spirits of turpentine and wipe it off before using it again."

Experiments with varieties

Turner conducted many experiments on varieties and new selections. In 1863 he presented an extensive evaluation of fruit varieties, recommending 14 apple varieties, five pear (including Turner's Early), five peach, three cherry, two quince, one grape, one currant, four gooseberries, one strawberry, and one raspberry — Turner's Seedling. In 1873 he described and evaluated elm, soft maple, rock maple, tulip, chestnut, white pine, red cedar, hemlock, Austrian pine, Norway spruce, and Tyrolese larch for street shading.

Two years later he presented another fruit variety list; in 1878 he evaluated several types of evergreen hedges; and in 1879 he recommended black walnut and honey locust for various purposes. In 1880 he stated, "The series of experiments I am prosecuting in girdling both fruit and nut-bearing trees of all sorts, at different seasons of the year, to force continuous bearing, is progressing more favorably than I had expected; I will report in full in due time."

Meteorology studied

In 1873, 1875, 1877, 1878, and 1879, he presented lengthy and scholarly papers on the forces causing changes in weather. Describing many of the theories concerning weather from ancient to modern times, he declared they had no foundation in fact. The facts needed for a science of meteorology, he urged, could be obtained if farmers made world-wide accurate observations.

He ended these papers by saying, "Yet the time will come when man can harness the wind and drive the storm. Many years may come and go before this great consummation is reached; yet I believe the intellect of man is or will, by its increasing development and with the increasing discovery of nature's laws, become sufficient to so direct the forces which control and produce ordinary local phenomena as to make them subservient to his will."

Ahead of his time

Although some of Turner's theories were unorthodox, he was without doubt a progressive thinker. Considering the lack of scientific facts of the day, he was often surprisingly close to being right.

C. J. Birkeland is Head of the Department of Horticulture.

The Forestry in 1893.

These 91-year-old eastern white pines were part of the original Forestry.

THE FORESTRY — one of our first experiments

R. W. LORENZ

PLANS FOR FOREST RESEARCH were formulated by the Illinois Industrial University the same year it opened its doors for instruction. This was in 1868, eight years before a Division of Forestry was established in the U. S. Department of Agriculture and 30 years before the first college of forestry was instituted in North America.

That year the University Committee on Horticulture, in a report to the Board of Trustees, requested funds from the state legislature for forestry research, and defended the request with these arguments: "To bring these useful trees within the bounds of culture and to utilize them is one of the objects of this industrial institution. To teach the people of the state how to add these products of the forest to their other crops, and thus add millions of dollars annually to the wealth of the state, to give labor a wider range and a more comprehensive field for its employment, are objects worthy of such an institution."

The appeal led to a legislative appropriation of $1,000 for trees and seeds. In 1871 the first forest trees were planted on the tract later to be known as "the Forestry."

This early beginning of forest research in the midwestern corn belt was truly the Land Grant Act in operation, implementing Jonathan Baldwin Turner's plan for a "state university for the industrial classes."

Planting and early care

The forest-tree plantation was established with 24 species on a 13-acre tract that had originally been under prairie grass but had been cultivated for 30 years. Drummer silty clay loam, a black soil with slow surface drainage, occupies a nearly level to depressional area, while Flanagan silt loam, a lighter soil with moderate surface drainage, occupies the gently sloping portions.

The central part of the tract was too wet for tillage, so an open ditch was dug to make the area dry enough for planting. According to the record, "the ground was put in good condition by plowing, harrowing, and the use of a 'clod crusher.'"

Planting was done with a shovel or spade. The hardwood species such as ash, elm, maple, and willow were planted on the lower, more moist areas, and the conifers on the higher, better drained areas.

All the early planting (1871) was done in rows 4 feet apart, except for pines, which were planted 2 feet apart. The arguments supporting this extremely close spacing were that the trees would grow more upright and that the trimmings would be a source of profit. Later plantings were in rows 8 feet apart, with 4-foot spacings within rows.

All trees were cultivated during the first few summers after planting and in addition were hoed twice a year for the first two years. During the winter of 1888-89 the conifers, except red cedar, were pruned to a height of 10 feet. Various degrees of thinnings were made in the early life of the plantation. Diameter growth was seriously retarded due to the extremely close spacing.

Results

The first comprehensive report on the plantation appeared in the Thirteenth Report of the Board of Trustees of the University of Illinois in 1886. It was written by T. J. Burrill, Professor of Botany and Horticulture, later to become Acting Regent of the University. Together with G. W. McCluer, he issued "The Forest Tree Plantation," Station Bulletin 26, in 1893.

In 1904 R. S. Kellogg of the U. S. Forest Service examined and measured the campus plantation as part of a plantation survey for central and northern Illinois. These results were published in 1907 under the title, "Forest Planting in Illinois."

For the next 30 years, interest in the forest plantation seemed to wane. In 1938 the Department of Forestry was organized in the College of Agriculture, and the following year a measurement of the remaining plantation furnished a record of periodic diameter and

R. W. Lorenz, Professor of Forestry, does research on the planting, care, and management of forest trees.

height growth over a span of some 70 years. Much of the information obtained appears in the accompanying table. Some of it was the basis for "The Growth of Conifers on Prairie Soil," by R. W. Lorenz and J. N. Spaeth.

After World War II, the University entered a period of rapid growth, and the Forestry gave way for other uses with greater priority. In 1951 the last remnant of the plantation was named Illini Grove and became a recreational area for students and staff.

Measurements of Species in the Plantation, 1886, 1904, and 1939

Tree species	1886		1904			1939[a]		
	Age, yr.	Height, ft.	Age, yr.	DBH,[b] in.	Height, ft.	Age, yr.	DBH, in.	Height, ft.
Boxelder (*Acer negundo* L.)	10	31	28	6.8	50	..	...	..
Silver maple (*Acer saccharinum* L.)	16	44	34	12.5	75	69	20.5	92
Sugar maple (*Acer saccharum* Marsh.)	14	22	32	6.0	35	67	10.4	58
Ailanthus (*Ailanthus altissima* (Mill.) Swingle)	6	18	24	6.0	40	59	13.7	66
Shellbark and shagbark hickories (*Carya laciniosa* (Michx. f.) Loud. and *ovata* (Mill.) K. Koch)	7	3	25	2.8	22	60	8.9	61
Southern catalpa (*Catalpa bignonioides* Walt.)	16	28	34	8.6	45	..	...	..
Northern catalpa (*Catalpa speciosa* Warder)	9	17	27	8.8	35	62	16.1	73
Green ash (*Fraxinus pennsylvanica* Marsh.)	16	40	34	7.4	50	69	15.1	84
Honeylocust (*Gleditsia triacanthos* L.)	5	13	23	6.3	35	58	14.7	75
Butternut (*Juglans cinerea* L.)	16	30	34	6.0	40	..	...	..
Black walnut (*Juglans nigra* L.)	14	37	32	8.3	55	67	13.4	72
Eastern redcedar (*Juniperus virginiana* L.)	16	16	..	..	..	..	...	..
European larch (*Larix decidua* Mill.)	16	34	34	7.3	50	69	11.9	67
Osage orange (*Maclura pomifera* (Raf.) Schneid.)	16	23	34	8.1	30	69	18.0	61
Norway spruce (*Picea abies* (L.) Karst.)	15	25	33	7.3	45	..	...	..
European black pine (*Pinus nigra* Arnold)	15	27	33	5.9	35	..	...	..
Eastern white pine (*Pinus strobus* L.)	15	25	33	7.5	40	68	12.8	60
Scotch pine (*Pinus sylvestris* L.)	15	29	33	8.6	40	68	13.7	47
Bur oak (*Quercus macrocarpa* Michx.)	2	2	20	4.9	35	55	12.9	67
White willow (*Salix alba* L.)	16	59	..	..	..	..	...	..
American basswood (*Tilia americana* L.)	6	17	24	7.0	35	59	14.0	72
American elm (*Ulmus americana* L.)	16	29	34	10.6	50	64	23.5	78

[a] Dominant and codominant trees only. [b] Diameter at breast height.

Adaptation of "Forestry" Species

Boxelder. Small to medium-sized; grew rapidly when young; poor form; short-lived.

Silver maple. Grew taller than any other hardwood in plantation; good form.

Sugar maple. Adaptable with good form; grew very slowly.

Ailanthus. Native of China; grew very fast when young; froze back to ground line during winter of 1884-85; sprouted from root collar the following spring.

Shellbark and shagbark hickories. Completely adaptable but grew slowly; somewhat limby.

American chestnut. Failed shortly after planting because white grubs fed on roots and rodents destroyed tops.

Southern catalpa. Failed; not hardy; heartwood decayed at an early age.

Northern catalpa. Completely hardy with good form; most trees had heart rot at an early age.

Green ash. Growth irregular, rapid, and exceeded only by silver maple; stems fairly straight; limby.

Honey locust. Medium growth; stems short; crowns large and limby.

Butternut. Excellent early survival and growth; trees failed from unknown causes at age 20.

Black walnut. Considered one of four best species in plantation in 1904; small diameter growth during last 40 years due to extremely close spacing.

Eastern red cedar. Straight-stemmed with many branches; growth slow.

European larch. A European conifer well adapted to Illinois prairies. Small diameter growth due to close spacing.

Osage orange. The "horse-high, bull-strong, and pig-tight" hedge made famous by Jonathan Baldwin Turner; medium-sized with short, stout, early-divided stems; branches and stems extremely crooked; wood extremely durable.

Norway spruce. Although well adapted to Illinois prairies, this European species made only poor to fair growth because it was on a low, wet area.

European black pine. Failed early.

Eastern white pine. Grew taller than either black or Scotch pine; extremely rapid growth to age 25 with rapid decline thereafter. This growth phenomenon is typical of most conifers on the heavy prairie soils of Illinois.

Scotch pine. Supposedly variety riga but a very poor seed source for Illinois; very crooked and poor growth; a failure.

Bur oak. Grew slowly with excellent form.

White willow. Grew faster in youth than any other species; limby with poor form; a failure by age 30.

American basswood. Completely adaptable with good growth and straight stems.

American elm. Good growth with short stems and wide spreading crowns.

Dwarfing of Potted Chr

One of the florist's difficulties has been obtaining potted plants of a desirable height. Frequently the plants grow too long and lanky. Several crops in particular, such as poinsettias, chrysanthemums, and Easter lilies, have always been problems.

Now, however, new dwarfing agents have been developed that will control plant height. The U. S. Department of Agriculture has screened many such chemicals in recent years. Two of them, Phosphon-D[1] and CCC[2], have proved most satisfactory.

To demonstrate the use of these materials, as well as to determine their response with Illinois soil and environmental conditions, several experiments have been conducted with poinsettias and chrysanthemums at the University of Illinois.

[1] Tributyl-2,4-dichlorolenzylphosphonium chloride.
[2] 2-chloroethyltrimethylammonium chloride. CCC was released to the commercial market this year under the trade name of Cycocel.

Phosphon-D powder is thoroughly mixed with the soil in a concrete mixer.

During the summer poinsettia cuttings are potted in soil treated with Phosphon-D.

Phosphon-D causes obvious dwarfing in young chrysanthemum plants. (Untreated control plant is on the left, plant with the highest concentration on the right.)

At first, Phosphon-D has a dwarfing e difference between the untreated cont concentration on right).

By Christmas, when the poinsettia plant phon-D has virtually disappeared.

Phosphon-D is still effective when the delay of 7 to 10 days in blooming, but no

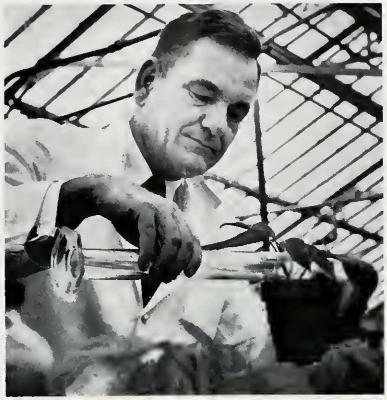
...themums and Poinsettias

R

...ung poinsettia plants, evidenced by the (left) and the treated plants (highest

...full bloom, the dwarfing effect of Phos-

...emums are in bloom. There is a slight ... in size of flower.



CCC is applied as a soil drench after cuttings have established a root system in a 4-inch pot, or about 2 weeks after potting. A curious phenomenon is that chrysanthemums and poinsettias show a selectivity in their responses to the two chemicals tried. As shown below, poinsettias respond to CCC, even though they don't respond to Phosphon-D. On the other hand, chrysanthemums, which respond to Phosphon-D, are not affected by CCC.

Shown in this picture is author J. B. Gartner, Associate Professor of Floriculture and Head of the Division of Floriculture.

At Christmas, poinsettia dwarfing is very evident when CCC is used. (Untreated control plant is on the left.)

The chrysanthemum plant receiving the highest concentration of CCC (right) differs very little from the untreated plant at left.

Better Cows Through Better Breeding Methods

N. L. VANDEMARK

CATTLE BREEDING has undergone many changes since the days when "taking Bossy to the neighbor's bull" was a real chore and a common sight. Although some of the fundamental principles that have permitted the changes were discovered before the turn of the century, those principles, along with numerous others more recently discovered, have been applied largely within the last 30 years.

Sire's value recognized

Prior to 1900, before the beginning of Dairy Herd Improvement Associations, cows were kept with little accurate measure of their productivity. Up until the 1920's, the bull was considered as little more than a "cow freshener."

The importance of the bull in contributing a sample half of what his daughters were, began to be noticed in the 1920's, at which time W. W. Yapp of the Dairy Department of the University of Illinois suggested the equal parent index. With the increased knowledge of the bull's importance, Bull Exchanges were arranged for replacing scrub and nondescript bulls with purebred bull calves on many farms. Then Bull Associations were formed so that the transmitting ability of a bull was tested on several farms and one dairyman would not have to gamble on the odds of improving his herd.

Out of these ventures dairymen learned that one out of three or perhaps only one out of five bulls, when mated to high-producing cows, would produce daughters that were better than their dams. As these better bulls were discovered, more and more dairymen recognized the value of using proved sires. However, the number of cows bred to a bull by natural mating was limited to 50 or 75 at most. Thus the need for artificial insemination was apparent.

Early artificial inseminations

Artificial insemination was first carried out in the 1780's by a curious and venturesome Italian scientist, Spallanzani, who obtained a litter of pups by injcting semen into a female dog. By filtering semen he also demonstrated that the sperm cells were responsible for the fertilization process.

From that time a hundred years went by before others repeated his experiments, and it remained for the Russians to apply the technique to farm animals about 1890. Even then few artificial inseminations were carried out until after World War I.

In the 1930's the Danes recognized the Russian techniques and formed cooperatives to utilize AI (artificial insemination) practices for cattle breeding. From Denmark the practices spread to the United States with artificial breeding cooperatives being formed in many states, including Illinois, in the late 1930's and early 1940's.

During the early days of artificial insemination of cattle, a single service of the bull was extended 1 to 2 or 1 to 4 with clear salt-buffer solutions, thus increasing by 3 to 5 times the number of cows that could be bred to a single bull. The semen extended with clear-buffer diluents could only be used for about one day, for that was the approximate time the sperm survived and remained fertile.

In 1939 Phillips and his associates at the University of Wisconsin discovered that egg yolk added to the clear diluents would greatly prolong the life and fertility of the sperm, particularly if the extended semen was gradually cooled to refrigerator temperature.

Using such a medium to supply nutrients and to buffer the sperm against the waste products produced, Salisbury and his co-workers, then at Cornell, pioneered with a series of investigations that greatly extended the usefulness of outstanding bulls. They gradually increased the rates of extending bull semen to the point where an average service of a bull (normally about 5 cc. of semen containing about 5 billion sperm) could be used to breed as many as 500 cows.

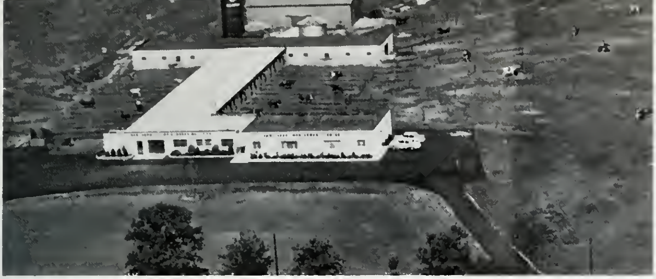
Furthermore, semen in such diluents could be held at refrigerator temperatures for 3 to 4 days with only minor losses in fertilizing capacity. Thus the way was paved for the rapid growth of AI in cattle, for semen could be kept fertile while it was being shipped all over the country.

During the 1940's many refinements and improvements were made, such as the addition of antibacterial agents to control bacterial growth and lessen the chances of spreading disease. These advances were soon reflected in the number of cows submitted to artificial insemination (see chart), and in the establishment of large cooperatives (statewide in many states) and private enterprises (some nationwide) to carry out cattle artificial insemination.

Recent advances

More, equally astounding advances came during the 1950's. One of these started in England in 1949 with the discovery that glycerol would protect spermatozoa so they could be frozen. This discovery led to the practice of cooling glycerol-protected semen to the temperature of dry ice (−110° F.) or liquid

N. L. VanDemark, Professor of Physiology in the Department of Dairy Science, received the Borden Award in 1959 for outstanding work in this field. He has been with the University since 1948.

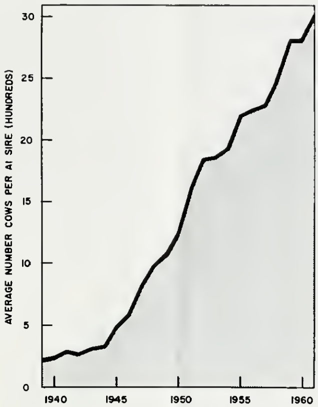


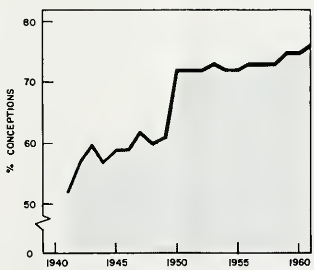
The artificial breeding bull stud of the Northern Illinois Breeding Cooperative is typical of many throughout the United States and other countries.

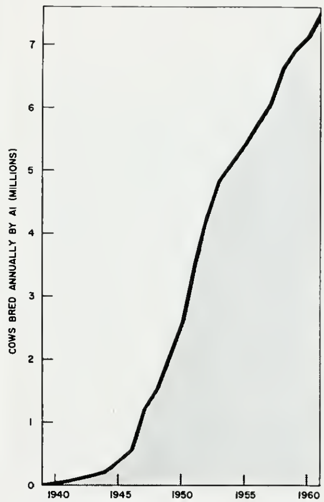
As shown by Mr. Warnecke of the Southern Illinois Breeding Cooperative, semen is sealed in 1-cc. ampules and then frozen and stored at −320° F. in large tanks of liquid nitrogen.

nitrogen (−320° F.), then storing it frozen for days, months, or even years. With careful procedures this semen was still fertile when thawed and used for breeding cows. After a number of refinements, many of which occurred in the United States, this practice has been adopted by many breeding units in the United States, Canada, and other countries.

Research during the 1950's on the physiology of the male reproductive system also contributed to greater utilization of outstanding bulls. It was learned that about 50 days are required for the making of a sperm cell. However, the tubules in which sperm are made in the bull are so long that an average mature bull may manufacture as many as 5 billion sperm cells daily. With this knowledge researchers, especially at Illinois and Pennsylvania, have shown that the number of potential offspring from a single bull may exceed 200,000 a year. Such a prediction is quite reasonable and is based on known scientific facts. It assumes, however, that man can improve storage and distribution methods, thus increasing the percentage of semen utilized. A further assumption is that research will overcome some of the cow's fertility problems, which still haunt the dairyman and veterinarian.







In the last 20 years, the number of cows bred annually by artificial insemination, the number of cows per sire, and the percentage of conceptions have all increased greatly.

Future possibilities

The future may bring even more astounding results. If superovulation and ovum transfer can be perfected, it will be possible to produce many calves from an outstanding cow. Poor cows would merely serve as incubators for the good cows' calves. Present bottlenecks, which need to be eliminated, are the difficulties of obtaining estrus synchronization and of developing nonsurgical techniques.

Perpetuating the ovarian tissue of one female by freezing and later transplanting it into another female could be an even more effective way of getting many offspring from a single female.

These techniques, already demonstrated in laboratory animals, will require more research and refinement before they are usable on a practical basis. However, if they are perfected and combined with the preservation of semen by freezing or perhaps by freeze-drying (which would require no lowering of temperature during storage), the possibilities of perpetuating certain families and lines of cattle become almost unlimited.

FOWLPOX IS STILL A THREAT

It can be controlled with our present knowledge; it will be more efficiently controlled as continuing research provides new information

L. E. HANSON

ALTHOUGH early research and field experience indicated that proper management and vaccination could control fowlpox satisfactorily, the malady remains a prominent poultry disease in the United States. In 1959 more outbreaks of fowlpox were recognized in Illinois than of either Newcastle disease or infectious bronchitis.

Signs and symptoms

Fowlpox has been recognized in poultry for many years. It is a viral disease, which causes lesions in the skin on feet, legs, combs, and wattles, and in membranes of the upper respiratory tract. It first becomes apparent when small vesicles (sacs filled with fluid) develop. The vesicles later grow together and erupt, forming characteristic scabs. In mature chickens, the lesions are most prominent on the wattles and combs (Fig. 1); in young chickens, on the legs.

Affected birds usually appear listless, develop respiratory disturbances, and stop laying eggs. The disease spreads through an entire flock over a period of weeks or months, affecting individual birds for 3 to 4 weeks. Death losses vary from mild to severe.

The virus causes plaques, or accumulations of cells, on the membranes of chicken embryos (Fig. 2). When either skin lesions or membrane plaques are examined under the microscope, large masses of viral particles (inclusions) are generally seen in the cytoplasm or outer portions of the affected cells (Fig. 3). The inclusions usually serve to identify the disease.

Early research

Much of the early research on fowlpox was conducted at the University of Illinois during the 1930's and 1940's.

Even before then, workers recognized that many species of birds were affected with pox. Repeated attempts were made to define the relationships between the many virus strains isolated from a variety of birds. In these studies, the viral relationships were primarily defined according to the susceptibility of different hosts, since serological tests gave unreliable results.

Vaccination with virulent virus was found to be of value in controlling pox. Scabs from the skin of affected birds were first used as the source of vaccine. Later research, conducted primarily by E. H. Barger, Robert Graham, and C. A. Brandly at Illinois, indicated that the inoculated embryonating egg is a valuable source of vaccine. It is relatively free of the contaminating bacteria found in the skin scabs first used. The work also indicated that the membranes of the inoculated embryo contain the greatest concentrations of virus and they were therefore used for vaccine.

L. E. Hanson, Professor of Veterinary Pathology and Hygiene and of Veterinary Research, has conducted research on a number of poultry diseases.

In later studies at Illinois, however, the embryo was found to contain enough virus that the entire embryo could be utilized, thus providing a less expensive vaccine. It was also demonstrated that adult laying chickens could be immunized with the mild pigeon pox virus without the decrease in egg production that is frequently caused by the fowlpox vaccine.

Recent developments

Despite the development of vaccines, the incidence of fowlpox remains higher than it should be. Frequently too little vaccine is used for vaccination, and many birds are never vaccinated at all.

Furthermore, the different viral strains have varying numbers and kinds of antigens. (Antigens are substances that stimulate an animal's resistance to a particular disease agent. This is done by changing gamma globulin, one of the blood proteins, into antibodies that combat the disease.)

Reservoirs of infection in domestic and wild birds also contribute to the widespread incidence of fowlpox.

The present vaccines, if properly prepared and administered, appear to stimulate a good measure of protection in chickens. However, the exact mechanism of resistance has not been definitely determined. Circulating antibodies have not been satisfactorily measured, so no adequate serologic test has been developed.

Recently at Illinois, an effort was made to study the serum antibodies by means of virus neutralization and precipitation tests. In the neutrali-

Scabs on the combs of mature chickens are characteristic of fowlpox. ***This photograph, as well as the others on this page, was taken during the studies made in the 1930's.*** (Fig. 1)

Small white spots are plaques, or accumulations of cells, on the chorio-allantoic membrane of a chicken embryo which has been inoculated with fowlpox virus. (Fig. 2)

zation test, the antibody content of serum is indicated by its ability to neutralize the virus. The precipitation test, as its name implies, depends on a precipitating reaction between serum antibodies and virus (antigen) to measure antibody content.

A low value for neutralizing antibodies was found in turkeys infected with fowlpox virus. Precipitation tests conducted in agar indicated that virus infection caused chickens to form antibodies, but the titers of antibodies diminished within several months.

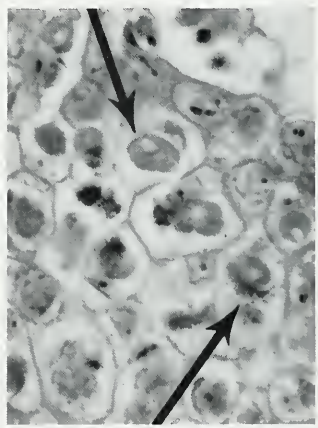
Virus has been found in the blood of apparently recovered turkeys. A circulating virus already in the blood could be partly responsible for low neutralization activity because the virus would combine with some of the antibodies. At the same time the circulating virus might keep a second virus from entering the cells, thereby increasing the bird's resistance to reinfection.

If virus can persist in turkeys for several weeks after lesions have disappeared, it may also persist in other birds. A knowledge of the reservoir of pox viruses in various avian hosts is vital to an effective control program.

To compare and classify isolated avian pox viruses, workers have studied a wide variety of birds that have been artificially infected with these viruses. However, such pathogenicity studies are not a satisfactory means of evaluation. Recent studies at Illinois suggest that the agar precipitation test may serve as a reliable means of comparing viruses. A number of viruses from chickens and turkeys were examined with this test, and the results indicated that all strains contained some of the same antigens. One strain appeared to contain antigens common to all the strains studied.

Chicken embryo tissue cells agglutinate when cultivated in the presence of fowlpox virus, thus providing a technique for measuring viral content and studying growth characteristics of viruses.

A recent refinement of the technique is to obtain tissue cultures in which the cells are just one layer thick. This permits the identification of viral strains by the characteristic size and shape of the plaques that they form. Such studies may be useful in determining how many antigenic strains are present in a viral population.



Arrows point to two of the inclusions (masses of viral particles) on the membrane of a chicken embryo infected with fowlpox virus. (Fig. 3)

Refinement and enlargement of the various new techniques hold hope of revealing basic information necessary for evaluating viral strains and improving control measures.

Isabel Bevier, pioneer in the Land-Grant movement

JANICE M. SMITH

"LADY BEVIER," "Miss Bevier," or "Belle" as she was variously referred to by some of her male colleagues, other co-workers and students, or close friends — was truly a pioneer in interpreting the Land-Grant idea through home economics.

Coming to the University of Illinois in 1900, she not only built up the Department of Home Economics here, but contributed greatly to the development of home economics throughout the country.

Her belief in the Land-Grant philosophy was developed in an address, "The Land-Grant Colleges and the Education of Women," which she gave at Ohio State University in 1920. After tracing briefly the early developments in the education of women, she stated:

"We come now to the work of the Land-Grant college in the education of women. These colleges were born in the minds of men who had the vision to see life whole and large. The Land-Grant college was a protest against narrowness in education, as the statement, 'While not excluding the classic, but adding agricultural and mechanic arts,' shows. These leaders recognized that a democracy demands that all people be educated and that a task so great could be met only by national resources. So, it seems to me, the first contribution which the Land-Grant college made to Home Economics was latitude in education, breadth.

* * *

"In the early days of my own work, I very soon learned to distinguish whether the passing visitor, of whom there were many, belonged to the Land-Grant college or to the traditional classical school, by the response which they made to my statement: 'We are working at the problems of the home from the scientific basis.' The man from the Land-Grant college said: 'Yes, the home opens up a very interesting field for the application of science.' The man from the classical school looked at me a little questioningly and said: 'Yes, yes — are we a little late for breakfast? Are the biscuits gone?' "

Later in the same address, Miss Bevier, looking into the future, made a statement which could serve as a Land-Grant goal for 1962-2062:

"It would appear that the Land-Grant college, in addition to the task to which it has responded so generously, namely, the strengthening and deepening of the scientific basis for the study of the home, must undertake to teach something more of the art and the beauty as developed in the social and economic aspects of our common life. The Land-Grant college must send forth men and women who shall be eager and able to use their knowledge of and skill in the practices and principles of the arts of the home . . . and so enrich country life not only in material ways but also in the finer and less tangible things of the spirit."

Many innovations

As a scholar, an intelligent, perceptive woman, an educator, and an innovator, Miss Bevier gave generously to Land-Grant education and philosophy. Among her innovations were the experimental house (1908) and the practice house (1914). In 1903 she undertook research in foods and in 1905, research in dietetics. She developed college curricula for undergraduate students desiring a liberal education or a combined liberal and professional education, and for graduate students. She organized an annual school for housekeepers and arranged homemakers' sessions at the annual State Farmers' Institutes.

These were all new ventures in the early 1900's and were soon adopted by other educators for newly developing home economics programs throughout the country. Our present-day home management houses and graduate study, research, and Extension programs have evolved from these early beginnings.

Her training and experience

Miss Bevier's early experience was varied and extensive. After teaching high school mathematics and Latin for three years, she taught chemistry, geology, physics, and botany at Pennsylvania College for Women for nine years. While there she developed a course in chemistry with applications to food and physiology which she later taught with great success at Lake Erie College.

Although her formal college training had been in mathematics and language, she carried on further studies at Case School of Applied Sciences, at Harvard University, and at Massachusetts Institute of Technology to develop her knowledge of physics and chemistry, particularly food chemistry. In pursuing this independent study, her purpose was to prepare herself for the application of scientific principles to the enrichment of homes.

Janice M. Smith, Head of the Department of Home Economics, is the third to have held that position since Miss Bevier. Ruth A. Wardall succeeded Miss Bevier, and Lita Bane followed Miss Wardall.

A broad program

As soon as Miss Bevier arrived in Urbana, in September 1900, she sought out leaders in architecture, engineering, and chemistry to see what the campus had to offer for her program. She was so successful in explaining her needs that courses were adapted, new courses were offered, and competent men from other departments contributed to the teaching of home economics courses.

Thus Dr. David Kinley, Professor of Economics and Dean of the Graduate School (later President of the University), helped to develop a course in household administration. In 1910 he outlined important aspects of the course before the American Home Economics Association. At later meetings other university colleagues described courses in housing and sanitary engineering.

Miss Bevier's capacity to identify scientific, social, and economic principles which might solve problems of the home thus enriched not only the Illinois program but those of other educators who attended the AHEA meetings. She herself contributed directly to the AHEA, playing a strong role at the early Lake Placid conferences from which the organization grew, and later serving as president and as a member of the editorial board.

Her ideas were also felt through the American Association of Land-Grant Colleges and Universities. In 1906 she addressed the association on the topic, "Home Economics in a College Course." The talk, which was well received, was undoubtedly important in interpreting this new area of study for Land-Grant administrators. After the Home Economics Section of the association was organized in 1917, she served as its chairman for two years.

Miss Bevier saw clearly the distinction that must be made between teaching at the elementary or secondary level and teaching at the university level. She also recognized the need for county Extension programs, correspondence courses, and technical schools. To prepare guides for educational programs at each level, she worked tirelessly on committees on nomenclature, subject matter classification, and curricula. Her ability to discriminate between basic concepts and practical applications was invaluable in this type of activity.

A writer

In addition to her rigorous efforts as an administrator, teacher, Extension worker, and organization leader, Miss Bevier found time to write. And she wrote well, with a touch of dry humor. A 1906 publication on the home economics movement was commended by John Dewey, the eminent educator, as being "not a mere record of the past — but 'indirect sociology,' the story of how women of needs and problems very like our own have been working out their educational salvation."

Her book, "The House," written in 1906 and revised in 1911, was used by the American School of Home Economics, Chicago, for its correspondence courses. It was also the text for an extremely popular course of the same name that Miss Bevier taught for several years. Much of the philosophy and architectural, engineering, and decorative principles are still relevant for one planning a home today, even though costs and materials have changed. One section is introduced thus:

"While the subject is 'The House,' it is almost impossible to separate it in thought from the home for which it stands. We all appreciate that the house is not the home, as the body is not the spirit, but as the body serves as the means of expression for the spirit, so in the houses we build and furnish we show our appreciation of beauty or lack of it, we give, quite unconsciously perhaps, our definition of home."

Turning to her book, "The Development of Home Economics," written in 1924 and revised in 1928, we again find much that is relevant for our programs today and for the years ahead. In discussing the teaching of home economics, for example, she says:

"Because of the belief that Home Economics will never accomplish, either for the home or the individuals in it, what it could — will even lose its place as a factor in higher education unless it holds to and emphasizes broad foundations in science, art, economics, history, and literature — the author feels constrained to ask for a careful consideration of the whole content of Home Economics in the hope that — 1, a clearer distinction may be established between what constitutes high school and college work; 2, that better proportion may be established among the divisions as given in the syllabus; 3, that art, economics, and social aspects may receive more emphasis; and 4, that research in all lines may be promoted."

Her influence on students

One of Miss Bevier's greatest contributions to Land-Grant colleges and to other institutions as well was made through her students. Whether they put their studies directly into practice in their homes or went on to one of the new professions, many served with distinction. Graduates of those years now often say, "I was one of Miss Bevier's girls."

Two major aspects seem to explain the success of Miss Bevier's students: (1) She taught them to think intelligently, to be creative, to persevere in the face of hardship, to be concerned with the welfare of others; (2) she was gifted in identifying human talent, in nurturing it, and in inspiring the individual with a responsibility to use this talent for human welfare.

I have been privileged to hear the reminiscing of distinguished alums who have told of a call or letter from Miss Bevier advising them of a new position. In spite of a natural reluctance to tackle the responsibilities, they undertook the job because they could not let their teacher down. Once the work was started, a way was found to do it.

Yes, Isabel Bevier was a Land-Grant pioneer who believed in opportunity for all through education. She worked tirelessly to express these ideals through home economics and has left guide lines for other pioneers through her writings, her teaching, and her students.

Farm income and expected future earnings of

200 FARMERS WHO DECIDED TO LEAVE FARMING

HAROLD D. GUITHER

WHILE OUR TOTAL POPULATION has multiplied nearly six-fold in the last 100 years, the number of farms in the United States has followed quite a different trend.

The 1860 Census recorded 2,044,177 farms in this country. The number rose to a peak of 6.812,350 in 1935 and then dropped to 3,703,642 at the time of the 1959 Census of Agriculture.

Illinois reached its peak in farm numbers in 1900 with 264,000. We now have around 154,000.

To find out what kinds of farmers leave farming, why they leave, and how they make the shift to nonfarm employment, I interviewed a representative sample of 200 central and northern Illinois farmers who left farming in late 1960 and early 1961.

Previous research on farm migration had revealed no information about the financial position of operators who leave farming and shift to nonfarm employment. Some of my questions therefore concerned income and financial resources.

Gross incomes

Those leaving reported 1960 gross farm incomes as follows:

Income	*Percent of farmers*
Under $5,000	15
$5,000 — $9,999	41
$10,000 — $19,999	32
Above $20,000	12

A significantly higher percentage of the 200 farmers had gross incomes between $5,000 and $9,999 than did the population of all farmers.

Net incomes

Almost 70 percent of the 200 operators had an estimated net income for 1959 of less than $4,000. The operators' estimated net incomes were as follows:

Net income	*Percent of farmers*
Under $2,000	33
$2,000 — $3,999	37
$4,000 — $5,999	13
Over $6,000	9
No answer	8

Net proceeds from closing out farm business

This study did not attempt to get a complete net worth statement, but an effort was made to find out how much net operating capital remained after the operators had paid all their debts. Real estate and personal assets were not included.

More than half of those leaving had from $1,000 to $10,000. Young operators were more likely to have no capital left than older operators.

Net proceeds from closing out business	*Percent of farmers*
None	13
Less than $1,000	4
$1,000 — $4,999	32
$5,000 — $9,999	28
$10,000 and over	13
Did not know	10

Use of money

Savings, buying a home, and setting up a new business were the principal plans for use of money taken out of farming. The breakdown was as follows:

Use of money	*Percent of farmers*[a]
Savings	45
Buying a home	37
New business	15

([a] Since some operators had no money left, while others planned several uses for their money, the total is not 100 percent.)

Expected earnings

Many operators had not found a job, some were not going to work, and others were either reluctant to estimate their first year's income or did not have any idea about what it would be.

From the limited information obtained, it appears that most of the 200 farmers, other than those retiring, would earn more during their first year off the farm than during their last year of farming. This was especially true of operators under 60 years of age.

Expected earnings	*Percent of farmers*
More	29
Same	7
Less	6
Did not know	7
No answer	51

Those who had decided to leave farming voluntarily were more certain about future earnings and expected higher incomes than those who were forced to leave.

Expected incomes varied widely as shown below:

Expected annual earnings	*Percent of farmers*
Less than $4,000	8
$4,000 — $5,999	19
$6,000 — $7,999	11
$8,000 and over	6
Did not know	56

Land resources

Among the farmers leaving, 73 percent were tenants, 12 percent were part-owners, and 15 percent owned all their land. Among all farmers in the area, 42 percent were tenants, 21 percent were part-owners, and 37 percent were owners.

Of those who owned land, only 21 percent planned to sell their farms, and 70 percent planned to rent them. The other 9 percent were undecided or planned to continue living on their land even though they were no longer operating a farm business.

Harold D. Guither is Assistant Extension Editor and Associate Professor of Agricultural Extension. This article is based on research that he did for his Ph.D. thesis.

Dr. T. S. Hamilton, Dean L. B. Howard, and Dr. M. B. Russell.

Dr. Russell Succeeds Dr. Hamilton as Associate Director of Experiment Station

After 45 years on the staff of the University of Illinois, Dr. T. S. Hamilton retired August 31 as Associate Director of the Agricultural Experiment Station. Dr. M. B. Russell, previously Head of the Department of Agronomy, is the new Associate Director.

A native of Paris, Illinois, Dr. Hamilton received his B.S. in chemistry from the University of Illinois in 1917 and became an assistant on the Experiment Station staff that same year. After serving in World War I as military instructor, he returned to the University staff, later earning his M.S. degree in chemistry and his Ph.D. degree in animal nutrition.

Dr. Hamilton's research in animal nutrition has won for him an international reputation. His primary interests have been in measuring the effects of different nutrients on the entire metabolic processes of animals, and in developing more precisely balanced rations. He has authored or co-authored two books and more than a hundred scientific papers.

He became Associate Chief of the Division of Animal Nutrition in 1939, Chief in 1944, and Division Head in 1952. In 1954 he became Associate Director of the Experiment Station.

In addition to his research, teaching, and administrative duties, Dr. Hamilton found time to serve on more than 300 committees during his years at the University. Some of these were College or University committees; for example, he chaired the committee to select a new University president in 1953-1954. Others were civic, state, or national committees, such as the Committee on Animal Health of the United Nations Food and Agriculture Organization. In 1960 he served for six months as advisor to the Vice Chancellor at the U. P. Agricultural University, Phoolbagh, India.

Although Dr. Hamilton is retiring as a member of the University staff, he will continue active in Experiment Station affairs, serving as administrative secretary for the North Central Agricultural Experiment Station Directors.

Like Dr. Hamilton, Dr. Russell is a recognized authority in his field, which is soil science, and is the author of many scientific papers. He was president of the Soil Science Society of America in 1955, and president of Commission I of the Sixth Congress of the International Society of Soil Science held in Paris, France, in 1956. When the society met in Madison, Wisconsin, in 1960, Dr. Russell served as program chairman.

Dr. Russell is president of the American Society of Agronomy and is also chairman of the Agricultural Board, National Academy of Sciences—National Research Council. This spring Secretary Orville Freeman appointed him to the U. S. Department of Agriculture Committee on Agricultural Science. The committee, composed of 15 eminent scientists, will continually evaluate the department's program of research.

Dr. Russell is a native of Michigan and a graduate of Michigan State University. He received the M.S. and Ph.D. degrees from Iowa State University, and was on the staff of both Iowa State and Cornell Universities before coming to Illinois in 1951 as Head of the Department of Agronomy.

Dean Louis B. Howard, when recommending Dr. Russell's appointment as Associate Director, commented that the University and the Experiment Station were "extremely fortunate in finding an Associate Director who thoroughly knows and understands Illinois agriculture, who has a thorough knowledge of the methods of scientific research, and who has held broad responsibilities in administrative work."

Dr. Hamilton will be honored at a symposium on protein nutrition and metabolism to be presented by the College of Agriculture October 16 and 17 in commemoration of the Land-Grant centennial. The symposium is dedicated to Dr. Hamilton, and also to Dr. H. H. Mitchell, Professor of Animal Nutrition, Emeritus, who preceded Dr. Hamilton as Head of the Division of Animal Nutrition; and to Dr. W. C. Rose, Research Professor of Biochemistry, Department of Chemistry, Emeritus.

FARM BUSINESS TRENDS

A CENTURY and more ago the federal government sold much farmland in tracts of 160 acres. This acreage, a quarter section, was thought to make an ideal family farm. That was at a time when most of the plowing was done with oxen, and planting and harvesting were done with simple hand tools or with crude machines.

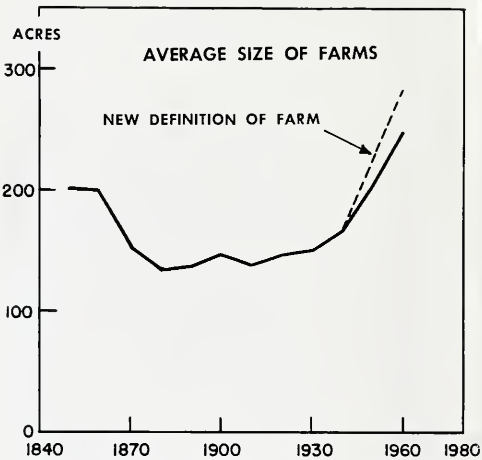
Many of these tracts were later divided into 80- and even 40-acre farms, as is shown by court house records and plat books. The average size of farms in the United States decreased from over 200 acres in 1850 to 134 acres in 1880.

Good horse-drawn machinery had been developed as early as 1850, and was continually being improved after that time. Even so, there was no general increase in average size of farms until after 1930, when tractor-drawn cultivating and harvesting machinery became generally available (Fig. 1). Despite the many changes that have occurred in recent years, the average farm is now little more than 40 percent larger than when we plowed and hauled with oxen.

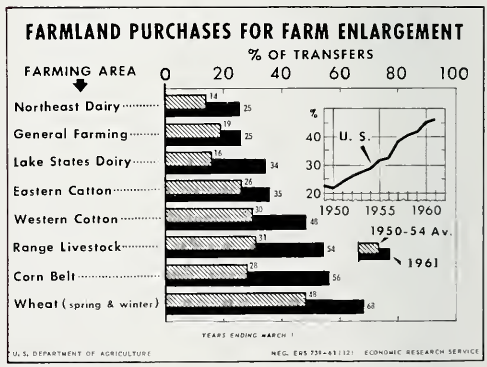
The process of recombining small land holdings into units suitable for modern machinery is slow and painful. We use two principal methods: (1) Farmers gain additional land to cultivate by renting from two, three, or more landowners. (2) Landowners purchase nearby land for farm enlargement.

Operating land for two or more owners enables a farmer to spread his machinery and labor costs over more acres, but it is often an unstable and unsatisfactory arrangement.

Enlarging farms by purchase of land is slow, although nearly half of all purchases in the United States in 1961 were for farm enlargement. As shown in Figure 2, the percent of transfers for enlargement varied greatly among different farming areas. — *L. H. Simerl, Professor of Agricultural Economics*



Farms are not much larger now than a century ago, although the new definition of farms excludes the small tracts that were formerly counted as farms but are actually rural residences. (Fig. 1)



Purchases of land for farm enlargement vary among regions for a number of reasons. Among them are topography, size of existing farms, and availability of land. In the northeast, for example, most of the land adjacent to an existing farm is often unsuited for farming. And many of the dairy farms in that area are already as big as one man can handle. (Fig. 2)

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Winter, 1963

ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

IN THIS ISSUE

Heavy feeding of corn silage cuts beef production costs and improves carcass grade (page 5).

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ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

CONTENTS

Winter, 1963 Volume 5, Number 1

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Louis B. Howard . . . . Dean and Director

M. B. Russell . . . . Associate Director

Adrian Janes . . . . Station Editor

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DEANS OF THE COLLEGE OF AGRICULTURE: GEORGE E. MORROW

George E. Morrow became Professor of Agriculture at Illinois in 1877, at a time when the entire University staff consisted of 14 senior faculty members and 13 instructors and assistants. The following year he was named the first Dean of the College of Agriculture.

People who knew Dean Morrow were particularly impressed by his winning personality, his personal integrity, and his ability as a lecturer, writer, and teacher. According to his successor, Dean Eugene Davenport, Morrow "won his way into the hearts of the people from Chicago to Cairo as he tramped the state speaking . . . for a better agriculture . . ." In addition to lecturing in Illinois, in neighboring states, and at national meetings, he contributed many articles to agricultural journals.

All this while, he was teaching courses in Farm Equipment, Animal Husbandry, Rural Economy, History of Agriculture, and Rural Law, and was also finding time for research. The most famous experiment with which he was associated — the comparison of corn grown continuously and corn grown in rotation with and without soil treatment — continues today on the plots that bear his name. After the Hatch Act of 1887 made a true experiment station possible, Dean Morrow, together with Thomas J. Burrill, supervised all the experiments of the station, which by 1888 totaled 60.

It was Dean Morrow's misfortune to serve at a period when, for reasons beyond his control, many Illinois citizens were either indifferent or actually hostile to the University, particularly the College of Agriculture. Enrolment in the College had reached its lowest point in 1894, when he left Illinois to become president of Oklahoma Agricultural and Mechanical College. However, the great resurgence of the Illinois College of Agricuture in the following decade must be partly attributed to the groundwork he laid through 17 years of unflagging effort.

Gains and Losses From APPLIED RESEARCH

GEORGE K. BRINEGAR

In the short run one person's gain may be another's loss — but in the long run these inequalities tend to disappear

EVERYBODY, as consumer, benefits from research in the long run, for the general level of living becomes higher each time new knowledge is applied to technology. Additional short-run gains accrue to producers who can utilize a particular technological advance. These facts have provided most of the arguments in favor of research.

But one producer's gain in the short run may be another producer's loss. If all the major effects of research are to be taken into account, we need to focus more attention on the short-term gains and losses.

Who gains and who loses in the short run depends on the kind of change that has resulted from a technological advance. In general, four kinds of change will occur, either singly or in combination, whenever research is applied in any "real" world situation.

Each type of change has a different economic impact on one or more of the factors of production, usually classified as land, labor, capital, and management. The impact of the changes in turn affects the gross and net incomes of farm and nonfarm producers and the real income (buying power) of consumers.

TYPE 1 CHANGE

Demand for a new product is created or demand for an existing product is increased. As a result, inputs used for the final product have a higher demand and value.

George K. Brinegar, Professor of Agricultural Economics, came to Illinois in 1960 from the University of Connecticut. He has served on a number of national economics committees.

Assume, for example, that people are willing to pay more for fish. As the fish monger gets more for the fish he sells, he pays more for the factors of production — including rent, fishermen, and his own work, management, and risk-taking activities.

If the fish-mongering operation grows big enough, the factors of production may be used more efficiently than they had been previously used in other sectors of the economy. Thus the physical productivity of these resources, as well as their value productivity, may be increased.

Effects on output and income

As demand for a commodity becomes greater, supply will increase unless it has a zero or negative elasticity.[1] If the commodity is an agricultural one, the total supply of agricultural products will increase unless the increased supply of the specific commodity is offset by a decreased supply of other products.

If aggregate demand for all agricultural commodities is increased, farmers as a group will have short-run gains. Nonfarm producers will have short-run losses because less will be spent on nonagricultural products.

If, on the other hand, aggregate demand for agricultural commodities is not increased, one farmer's gain will be another farmer's loss. In the long run, the gains and losses by agricultural and nonagricultural producers will largely slip away as people adjust to the new conditions.

Consumers will be better off in both the short and the long run. (This assumes that consumers know what they want, that what they want is "good" for them, and that output increases.)

It should be noted that, while research can increase the demand for agricultural products, it has usually tended to do the opposite by creating substitutes for these commodities. For example, mechanical power has been substituted for horse power, and synthetic detergents have greatly reduced the use of soap.

TYPE 2 CHANGE

A new discovery increases the physical productivity of a factor of production in its agricultural uses. The development of hybrid corn exemplifies such a change. Not only was there a direct increase in physical productivity of seed, but there was an indirect increase in the productivity of land and other inputs.

Effects on the value of productivity of seed corn and other inputs were more complex, requiring an analysis of the supply and demand characteristics of corn and the factors used in corn production.

Effects on output and income

When a factor of production becomes more productive in its agricultural uses, the output of commodities using this factor will increase. A possible exception would occur if a commodity could be produced only with fixed proportions of factors and if one factor were fixed in supply. This possibility is so remote, however, that it can be disregarded.

The price of a commodity produced with the factor of increased productivity will decrease, as will the price of competing commodities. The

[1] Supply rarely if ever has a zero or negative elasticity. A zero elasticity means that supply would not be affected by a change in price. A negative elasticity means that supply would move in the opposite direction of price. Supply elasticity is practically always positive, with supply increasing as price increases and decreasing as price decreases. Demand elasticity, on the other hand, is rarely if ever zero or positive. It is nearly always negative; that is, the amount purchased increases as price decreases, and decreases as price increases.

prices of complementary commodities, on the other hand, will increase.

As a commodity increases in supply and declines in price, total revenue from its sale will depend on elasticity of demand. If demand is elastic, farmers producing the commodity can sell enough to make up for the price decline and increase their gross and their net incomes for the short run. Other farmers and nonfarm producers will have declining incomes, while consumers' real income will go up.

It is more likely, however, that demand will be inelastic.[1] If so, gross income of farmers producing the commodity will decrease. The same thing will probably happen to net income, since the management factor is not elastic enough in supply to prevent a decrease in the returns to management. Gross and net incomes of other farmers and nonfarm producers will rise, as will the real income of consumers.

Whether demand is elastic or inelastic, producers' gains and losses are short-term effects which will tend to slip away in the long run. Consumers will gain in both the short and the long run.

The short-term effects on gross farm income in the aggregate will depend on elasticity of demand for total farm output. The same thing is true of net farm income in the aggregate if the prices of production factors remain the same. With an inelastic demand for all agricultural commodities and an expanding output, net farm income will decrease. That is the situation now. With an elastic demand, net farm income will increase. Net income of nonagricultural producers will have the opposite trend of agricultural income.

Again, the short-run gains and losses to producers will tend to disappear over a period of time while consumers will continue to benefit.

[1] Demand is inelastic when the amount purchased changes less than 1 percent for every 1-percent change in price. Demand is elastic when amount purchased increases more than 1 percent for every 1-percent decrease in price (or decreases more than 1 percent for every 1-percent price increase).

TYPE 3 CHANGE

A discovery increases the physical productivity of a factor in its nonagricultural use. Color television, for example, increased the productivity of capital. As with the Type 2 change, it would be analytically useful to distinguish between physical and value productivity changes.

Effects on output and income

Again output of commodities using the factor will increase. Short-term effects on farm and nonfarm income are just the opposite of those resulting from a Type 2 change. Once more these short-run effects tend to disappear in the long run. And the consumer benefits in both the short and the long run.

TYPE 4 CHANGE

A factor of production increases in supply, thus decreasing in price. This type can be resolved into a Type 2 or Type 3 change or a combination of the two. When a factor of production increases in supply, the cause has to be an increase in the productivity of a factor at an earlier stage of production.

Effects on output and income

The immediate impact of a Type 4 change is more complex and harder to measure than the impacts from a Type 2 or Type 3 change. A Type 2 change was assumed to occur only in agriculture; a Type 3 change, in nonagriculture. Since a Type 4 change occurs in both agriculture and nonagriculture, we have to consider the relative size of the changes in the two sectors of the economy. If the increase is greater in agriculture, effects are like those of a Type 2 change; if greater in nonagriculture, the effects of a Type 3 change result.

CONCLUSIONS

Even though the technological changes resulting from agricultural research may bring short-run losses to farmers, this is not adequate reason to slow up such research. For one thing, everyone, in the role of consumer, benefits in both the short and the long run. For another, the same basic knowledge that brings a short-run loss to farmers can also generate a short-run gain when applied in a different way. Finally, if agricultural research were restricted, a case could be made for restricting nonagricultural research as well. This would logically lead to the conclusion that new knowledge is bad — a notion that has been rejected for the past 500 years or so.

In positive terms, when a particular type of research appears to be running ahead of other types — creating imbalance and hardships — the cure is to speed the lagging types rather than to slow down the advancing type.

When we consider the analysis of gains and losses resulting from the accumulation of knowledge, it seems reasonable that the short-run costs should be shared by all since the gains accrue to everyone in the long run. However, if the notions of efficiency and economic growth are accepted, not every method of sharing these costs is appropriate. Only methods that do not lessen the gains from research are admissible.

A number of special inferences can be made as to types of research and resident and extension teaching programs that will aid farmers the most:

More attention should be directed toward speeding long-run adjustments by farmers and others, so that short-run losses will be more rapidly eliminated.

High priority should be assigned to developing methods by which the short-run costs of the application of research can be shared equitably.

Rate of economic growth should be speeded so that the real income effects will swamp the obsolescence effects of new technology.

More attention should be directed toward increasing the value productivity — not just the physical productivity — of the factors of production now used in agriculture. The most important of these is people, for not only are their abilities and skills a factor of production, but the welfare of farm people, as of all people, is in itself an end of research.

Better beef at less cost can be produced by
HEAVY FEEDING OF CORN SILAGE

A. L. NEUMANN

THE FUTURE of the beef cattle finishing business in Illinois could well hinge on the use that is made of corn silage. No crop approaches corn in the amount of TDN (total digestible nutrients) produced on an acre. When the entire plant is harvested at its most nutritious stage as silage, yields of around 6,000 pounds of TDN per acre are not unusual for 100-bushel corn. This compares with about 4,500 pounds when corn is harvested as grain.

Aside from its excellent nutrient qualities, corn silage is highly adapted to automation. This fact is doubtless responsible for much of the increased use of corn silage.

Further advantages of corn silage have been brought out by recent studies in the Beef and Meats Divisions of the Animal Science Department. Extensive feeding of corn silage lowered beef production costs. It also produced carcasses with less outside fat and a higher grade than carcasses of animals full-fed grain.

Four feeding plans

Tests were conducted with heavyweight steer calves in 1960 and 1961. Average initial weights were 476 pounds the first year and 575 pounds the second year. Final slaughter weights averaged about 1,050 pounds for all steers.

In each test the steers were divided into four lots. All lots were finished on a basal ration of cracked shelled corn, protein supplement, and corn silage; and all received the same amounts of vitamin A, minerals, and salt. The control lot was on the basal finishing ration throughout the test; the others were fed silage for varying periods before being put on the basal ration. These, briefly, were the four feeding plans:

Plan 1. Full-fed cracked shelled corn, limited corn silage, and soybean meal until an average slaughter weight of 1,050 pounds was reached (control lot).

Plan 2. Full-fed corn silage and soybean meal for 112 days, then fed Plan 1 ration to same slaughter weight.

Plan 3. Same as Plan 2 except the heavy corn-silage feeding period was extended to 168 days.

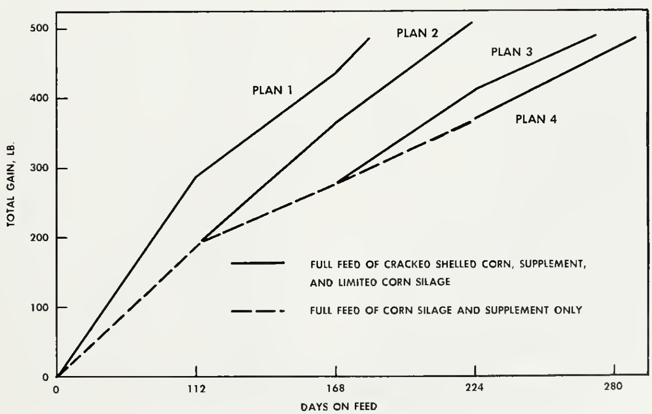
Plan 4. Same as Plan 2 except heavy corn-silage feeding continued for 224 days.

The lengths of time that the four lots were on the basal grain ration during the second test are shown in the chart. As the heavy silage-feeding period lengthened, a shorter grain-feeding period was required to achieve the same slaughter weight.

Feed requirements for each plan were carefully measured. On-foot grades were estimated in the feedlot to evaluate the effects of feeding plans on apparent slaughter merit. Members of the Meats Division used more precise measures to evaluate the carcasses after slaughter.

All steers were slaughtered in the University abattoir. Thickness of fat-cover over the rib, area of the loin-eye, and yield of retail-trimmed cuts were determined, as well as dressing percent, carcass grade, and similar carcass measurements.

A. L. Neumann, Professor of Animal Science, inspects carcasses with B. C. Breidenstein, Associate Professor of Meats Technology.



Total gains of steers fed finishing and growing rations for varying periods.

Table 1. — How Length of Heavy Corn Silage Feeding Period Affected Feed Requirements, 1961

A. Heavy silage-feeding phase

Item measured	Days on heavy silage			
	0	112	168	224
Total gain in period, lb.	....	210	272	372
Average daily gain in period, lb.	....	1.86	1.68	1.66
Average daily ration, lb.				
Corn silage	....	34.1	35.8	34.1
Soybean meal	....	1.5	1.5	1.5
Total feed per steer				
Silage, lb.	....	3,819	6,014	7,638
Silage, ton	....	1.91	3.01	3.82
Soybean meal, lb.	....	168	252	336
Feed per hundredweight gain, lb.				
Corn silage	....	1,819	2,211	2,054
Soybean meal	....	80	93	90
Feed cost per hundredweight gain, dollars[a]	....	12.29	14.78	13.87
Gain per ton of silage fed, lb.	....	110	91	95
Gain per acre of silage fed, lb.[b]	....	1,980	1,638	1,710

B. Grain-feeding phase

Item measured	Days on full feed of grain			
	196	112	105	63
Total gain in period, lb.	487	304	217	97
Average daily gain in period, lb.	2.48	2.71	2.05	1.54
Average daily ration, lb.				
Corn, cracked shelled	12.7	14.6	13.9	12.8
Soybean meal	1.5	1.5	1.5	1.5
Corn silage	15.9	18.7	18.8	14.0
Total feed in period				
Corn, lb.	2,489	1,635	1,459	806
Corn, bu.	44.5	29.4	26.0	14.4
Soybean meal, lb.	294	168	157	94
Silage, lb.	3,116	2,094	1,774	882
Feed cost per hundredweight gain, dollars[a]	15.84	16.44	21.07	25.06

C. Combined silage- and corn-feeding phase

Item measured	Days on heavy silage			
	0	112	168	224
Days on full feed of corn	196	112	105	63
Total days to slaughter weight	196	224	273	287
Average initial weight, lb.	576	581	577	578
Average final weight, lb.	1,063	1,095	1,066	1,047
Average total gain, lb.	487	514	489	469
Average daily gain, lb.	2.48	2.29	1.79	1.63
Total feed per steer				
Corn, cracked shelled, bu.	44.5	29.4	26.0	14.4
Total corn, bu.[c]	50.7	41.2	41.6	31.4
Corn silage, ton	1.56	2.96	3.90	4.26
Soybean meal, lb.	294	336	409	430
Corn acreage utilized per steer[d]	0.64	0.53	0.54	0.42
Steers fed per acre of corn	1.56	1.89	1.83	2.38
Steer gain per acre of corn fed, lb.	810	971	896	1,116
Feed per hundredweight gain, lb.				
Corn, cracked shelled	512	318	296	172
Corn silage	640	1,111	1,593	1,817
Soybean meal	60	65	84	92
Feed cost per hundredweight gain, dollars[a]	15.84	14.52	17.25	16.21
Total feed cost per steer, dollars	77.14	74.63	84.35	76.01

[a] Feed costs: corn silage, $10 per ton; soybean meal, $80 per ton; cracked shelled corn, $40 per ton.
[b] A yield of 18 tons silage or 80 bushels corn was used.
[c] Includes the corn in the silage, assumed to equal 15 percent of the weight of the silage.
[d] Includes both the corn fed as cracked shelled corn and the corn silage.

Effects on gains and costs

Differences in rates of gain are graphically shown in the chart. More detailed results for 1961 are given in Table 1.

Average daily gains during the heavy silage-feeding phase (Table 1A) were somewhat lower in 1961 than in 1960. The lighter calves used in the first study gained about 2 pounds a day.

Rate of gain was about the same for all three lots while on heavy silage in 1961. The same thing was true of cost of gain. It should be noted that about 1 ton of silage and 100 pounds of supplement were required for 100 pounds of gain, regardless of length of silage-feeding period. All calves daily ate corn silage equal to 5 percent of their weight.

Assuming a cost of $80 a ton for supplement and a value of $25 for steer gains, the corn silage fed to steers in a growing-type ration would have a value of at least $20 a ton.

As length of silage-feeding period increased, finish of steers at the end of the period also increased. This could conceivably affect price received if it were desirable to sell the steers at the end of the silage-feeding period.

Results of the grain-feeding phase are reported in Table 1B. Steers that were full-fed grain for 196 days (Plan 1) made very satisfactory gains (2.48 pounds) for heavy-weight calves, and certainly a feed cost of $15.84 is encouraging. Even in this lot silage consumption averaged 15.9 pounds a day, which undoubtedly accounted for the efficient gains.

Although the cracked, shelled corn was fed to appetite, the steers consumed an average daily amount equal to 1.5 percent of their body weight. The level of corn could have been increased to 2 percent of body weight daily by reducing silage level, but costs would have increased.

Daily gains of steers full-fed for 112, 105, and 63 days were 2.71, 2.05, and 1.54 pounds respectively. These results were about as expected in view of the differences in condi-

tion at the beginning of the grain-feeding phase. Naturally, as gains decreased, feed costs increased.

Gains and feed requirements for the entire feeding program for each lot are shown in Table 1C. Only 28 more days were needed to finish steers fed only silage and supplement for 112 days than to finish steers full-fed from the start. And steers fed silage and supplement for 224 days required only 14 more days to finish than those fed silage and supplement for 168 days.

Overall average daily gains decreased as length of the heavy-silage feeding period increased. However, this additional time in the feedlot was more than offset by a reduction in bushels of corn needed to finish the steers. Compared with the control lot, the reductions for the lots on the other plans were: Plan 2, 9.5 bushels; Plan 3, 9.1 bushels; Plan 4, 19.3 bushels. Some of the saving in corn, however, was offset by higher total supplement costs.

We can appreciate the cornstalk's contribution when we consider how much a heavy silage program increases the number of steers that can be fed with an acre of corn. Plan 2 increased the number of steers by 21.2 percent over Plan 1; Plan 3, by 17.3 percent; Plan 4, by 52.6 percent. Use of Plan 4 produced 305 more pounds of finished steer per acre than did Plan 1.

Overall costs of liveweight gain favored Plan 2, but Plan 1 was a close competitor. In the first year's study, Plan 2 was also the most economical, but Plan 1 was the costliest. In both tests, however, the differences between the high and low lots were relatively small, and all plans produced gains at very low costs.

Table 2. — How Length of Heavy Silage-Feeding Period Affected Feed Requirement and Carcass Grade and Yield, 1961

Item measured	Days on heavy silage			
	0	112	168	224
Days on full feed of corn	196	112	105	63
Total days to slaughter date	196	224	273	287
Average slaughter date	May 8	June 4	July 25	Aug. 8
Average slaughter weight, lb.[a]	1,068	1,100	1,083	1,047
Chilled carcass weight, lb.	669	671	669	630
Dressing percent	62.7	61.0	61.8	60.2
Carcass grade[b]				
Conformation	19.1	18.8	18.8	18.3
Finish	19.2	18.7	19.7	18.7
Marbling	18.6	17.8	19.3	22.0
Overall	18.3	17.8	19.3	20.3
Fat cover over 13th rib, in.	0.63	0.59	0.63	0.39
Loin-eye area, sq. in.	11.21	10.32	10.75	10.85
Loin-eye area per hundredweight carcass, sq. in.	1.68	1.54	1.61	1.72
Carcass value per hundredweight[c]	$ 35.64	$ 35.24	$ 36.44	$ 37.24
Total carcass value	238.43	236.46	243.78	234.61
Total cost of steer and feed[d]	226.90	225.69	224.37	226.29
Return over steer and feed cost	11.53	10.77	19.41	8.32
Return over steer and feed cost per acre corn fed	17.99	20.36	35.52	31.61

[a] These weights vary slightly from weights off the feeding test because not all steers were slaughtered on the same day.
[b] High choice, 21; choice, 20; low choice, 19; high good, 18; good, 17.
[c] Based on a wholesale price of $34.60 and $37.00 per hundredweight for good and choice carcasses, respectively.
[d] Includes a laid-in cost of $26.00 per hundredweight for the steers at start of test.

Carcass data

It wasn't surprising to find that the four lots differed in carcass data in 1961 (Table 2), although the differences in 1960 were smaller than would normally be expected.

Because of the differences in energy level of ration, in rate of gain, and in age at slaughter, the on-foot grades of the cattle were different from the carcass grades. On-foot grades were at the lower end of choice for cattle fed according to Plans 1 and 2, and at the upper end of good for those fed by Plans 3 and 4. These grades were actually reversed by the rail grades. Had these steers been sold on foot, the financial outcome would have differed from the reported one, which is based on rail grade and yield.

Dressing percent followed the on-foot grades, the Plan 1 cattle dressing 62.7 percent and the Plan 4 cattle, 60.2 percent, exactly the same as in the previous year. The other two lots were intermediate and just about equal.

Generally speaking, as the heavy silage-feeding period lengthened, the outside fat or bark was reduced, the marbling was increased, and the yield of trimmed lean cuts improved when all cattle were killed at comparable weights. In 1960 the Plan 1 cattle scored lowest in marbling; in 1961 they scored next to lowest.

Total carcass value was computed for each steer by using the dressing percent and wholesale price for carcasses of its particular grade. Differences in marketing dates and their effects on price were not taken into account in either 1960 or 1961 since seasonal patterns have been rather disturbed in the past two years. The prices of $37.00 and $34.60 for choice and good grade carcasses, respectively, represent a difference of 80 cents per hundredweight for each third of a grade, a normal spread.

The returns per head over feed and feeder steer costs favored Plan 3 by about $8.00 a head. When we also remember that more steers are fed per acre of corn with heavy silage feeding, we can note a substantial positive relationship between length of heavy silage-feeding period, profits, and volume of business.

It should be pointed out that performance was acceptable and profitable in all plans both years. In 1960 increasing the silage content of the ration improved carcass quality slightly, but in 1961 the improvement was substantial. Feeders moving more than one drove of long-fed steers through a feedlot annually might not find this program as applicable as the Corn Belt feeder who normally feeds only one drove a year.

Greater Resistance to Northern Corn Leaf Blight Is on the Way

A. L. HOOKER

A. L. Hooker, Associate Professor of Plant Pathology and Agronomy, observes a row of blight-resistant corn in the disease nursery at Urbana and compares it with a susceptible inbred in the adjacent row. (Fig. 1)

A recent breakthrough in research may virtually eliminate northern corn leaf blight, at present a major corn disease in Illinois and adjacent states.

Development and damage

The disease is caused by a fungus (*Helminthosporium turcicum*) that stays alive in old corn leaves over winter. The following season spores of the fungus are carried by wind to the new crop. If moisture is present they germinate and penetrate corn leaves within a few hours.

The fungus develops mainly in the xylem (water-conducting tissue of the leaf). Here water movement stops, resulting in wilted areas which soon die. The fungus then grows into this dead tissue and produces thousands of new spores each night during periods of high humidity and dew formation. By this means the fungus spreads rapidly and may kill most or all of the leaves by the end of August. A whole field may look as if the corn had been killed by frost.

Infected areas show up first on the lower leaves. These areas, called lesions, are long, elliptical and grayish-green or tan. Individual lesions may become as large as 6 inches long and 1.5 inches wide. Several may form close together or coalesce, killing large areas of the leaf. As the season progresses, lesions increase in number and form higher on the plant.

Damage occurs in the form of yield losses and lodged corn. If the disease is severe within 2 or 3 weeks after full silk, more than half the crop may be lost. Infections developing 6 weeks after silking, however, do little damage.

Plants weakened by leaf-blight infection are more susceptible to stalk-rotting fungi, which cause further damage and lodging.

Resistance needed

Most present-day hybrids, especially those adapted to northern Illinois, are susceptible to leaf blight. A few partially resistant hybrids have replaced the most susceptible ones, but they have only reduced the problem of leaf blight without overcoming it.

These partially resistant hybrids have been developed through state, federal, and private breeding programs during the last 20 years. The best sources of resistance have been late-maturing inbred lines that are not adapted to the Corn Belt. Their resistance is a quantitative character, expressed primarily by a reduction in lesion number, and depends upon many genetic factors. Adding such resistance to Corn Belt inbreds through breeding has been time-consuming, expensive, and very difficult to do without also changing maturity and other characteristics.

A new type of resistance

Now a new kind of resistance has been discovered in the corn disease research program at Urbana (Figs. 1 and 2). It promises to be much more effective than the quantitative resistance heretofore used. So far this new type of resistance has been found in the Georgia inbred GE440, Ladyfinger popcorn from Iowa, and a few other strains.

When attacked by the fungus, these resistant plants develop chlorotic (yellowish) lesions which can be easily distinguished from the wilted and dead lesions on susceptible plants. The chlorotic lesions are only one-eighth as large as the usual lesions, and their centers die later in the season. The fungus grows very poorly in the xylem of resistant plants, and it produces almost no spores.

In laboratory tests of sporulation, sections from lesions on both susceptible and resistant plants were placed in covered dishes and kept under high humidity. Sporulation occurred after 12 hours on lesions from susceptible plants, but it did not occur until after 72 hours on lesions from resistant plants.

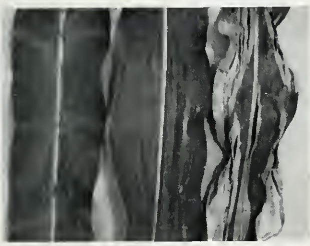
Even then, for every spore per microscope field produced on a resistant lesion, 157 spores were produced on a similar area of a susceptible lesion. When living plants were placed in greenhouse humidity chambers, spores formed on susceptible lesions overnight but no spores were observed on resistant lesions after 7 days.

The delayed leaf-killing on resistant plants, reduction in lesion size, delay in spore formation, and reduction in number of spores all mean that the fungus would have a very difficult time reproducing and spreading in a field of resistant corn. Such fields would suffer little if any damage from the disease.

Resistance simply inherited

Two of the resistant corn selections were crossed with over 60 susceptible corn inbred lines. Several such hybrids were advanced to the F_2 generation and backcrossed to the susceptible inbred to study the genetics of resistance. Disease evaluations employing artificial inoculations were

Resistant plant (left) has a few chlorotic lesions in which the fungus produces almost no spores. Susceptible plant (right) has many lesions which kill much of the leaf and produce thousands of spores nightly in damp weather. (Fig. 2)



A resistant hybrid (center) is produced when a resistant inbred (left) is crossed with a susceptible inbred (right). Greater resistance results when two resistant inbreds are crossed. (Fig. 3)

made both in the greenhouse and in the field.

All hybrids produced with the two resistant selections were resistant to the disease (Fig. 3). The segregating populations showed that resistance is due to a single dominant gene (see table). There was an exact agreement between seedling reaction in the greenhouse and adult plant reaction in the field. Plants having the dominant gene for resistance developed chlorotic lesions, while those lacking the gene developed the usual lesions of susceptible plants.

Breeding methods

Since resistance is due to a single dominant gene, the most efficient breeding procedure is to add this gene to susceptible but otherwise good inbred lines by backcrossing. For example, Ladyfinger popcorn is crossed with the widely used, susceptible inbred WF9. The resulting hybrid will have 50 percent of its germplasm from Ladyfinger popcorn and 50 percent from WF9. If this hybrid is crossed with WF9, the resulting progeny from this first backcross will have 25 per cent of its germplasm from Ladyfinger popcorn and 75 percent from WF9. Half of these plants will be resistant and half will be susceptible; the resistant plants are identified by disease tests and crossed with WF9.

This procedure is repeated four more times. Each generation the amount of germplasm from the resistant but poor-quality Ladyfinger popcorn is half that of the previous generation, while the amount of germplasm from the desirable inbred WF9 increases. At the sixth backcross generation, a uniform resistant selection is made that will have over 99 percent of its germplasm from WF9. In other words, it will be essentially like the original selection of WF9 except that it will be resistant to leaf blight.

Observed and Expected Segregations for Reaction to Leaf Blight Assuming a Single Dominant Gene for Resistance

Cross	Observed No.		Expected No.	
	Res.[a]	Sus.[a]	Res.[a]	Sus.[a]
(Adult plants in field)				
WF9 x GE440 (F_2)	160	50	157.5	52.5
Oh41 x LP[b] (F_2)	186	63	186.8	62.5
(W22R x GE440) x W22R	97	110	103.5	103.5
(W22R x LP) x W22R	102	98	100.0	100.0
(Seedlings in greenhouse)				
B14 x GE440 (F_2)	176	65	180.8	60.2
W22R x LP (F_2)	83	26	81.8	27.2
(B14 x GE440) x B14	52	62	57.0	57.0
(W22R x LP) x W22R	54	55	54.5	54.5

[a] Res. = resistant; Sus. = susceptible.
[b] LP = Ladyfinger popcorn.

By improving four inbred lines that make up a double cross hybrid, an improved hybrid can be produced which will be unchanged from the original hybrid except for the added resistance to leaf blight.

Resistance from two sources is being added to about 30 inbred lines by the Departments of Agronomy and Plant Pathology working in cooperation. These are widely used lines that will serve to produce resistant hybrids adapted to the various regions in the state. In addition, the resistance is being shared with workers in other states and with commercial hybrid seed corn companies. Through the combined efforts of all these people, we can expect rapid progress in adding leaf-blight resistance to corn hybrids.

Will resistance last?

Any parasitic disease results from the interaction of the genetic system of the host and the genetic system of the fungus or other disease-causing organism. Through breeding, man can change the genetic system of the host and produce a resistant variety unfavorable to the fungus. New strains of the fungus may develop, however, which can overcome or break this resistance. If this happens, the resistant variety becomes susceptible for all practical purposes.

Many strains or collections of the leaf-blight fungus have been tested in the greenhouse to find if any can break down resistance to leaf blight. So far none has been able to do so. Strains with this ability may exist undetected, however, or may be developed through genetic changes. Such changes frequently occur in organisms like those causing rusts and smuts of oats and wheat but are less likely to happen in fungi having genetic systems comparable to that of *H. turcicum*. Continued and expanded research on the genetics of host-parasite systems, however, is needed to be sure that resistant varieties or hybrids will protect farmers' fields from disease.

OIL AND PROTEIN CONTENTS OF CORN

have been greatly changed in long-time selection experiment

Each long-selected strain has its own distinctive ear type. L to right: High Protein, Low Protein, High Oil, Low Oil. (Fig.

EARL R. LENG

IN 1896 Cyril G. Hopkins began a selection experiment with corn which has become internationally known and a landmark in the history of plant improvement. As a chemist, Dr. Hopkins was keenly interested in improving agriculture through application of his special field of science. After a detailed study of the chemical constituents of the corn kernel, he began a research program to learn if selection could significantly change the chemistry of corn grain.

Four strains selected

From a sample of "Burr White" open-pollinated corn, Dr. Hopkins and his assistants selected 163 ears for chemical analysis. The oil and protein content of each ear was determined, and the data were used to select foundation seed ears for four strains: "Illinois High Oil," "Illinois Low Oil," "Illinois High Protein," and "Illinois Low Protein."

As the names indicate, selection was practiced for high oil, low oil, high protein, and low protein content, each in a different pedigreed strain. For the first 28 generations of the experiment, each strain was grown in its own isolated plot, where selection was by the "ear-to-row" method. Since then, the strains have been maintained by hand pollination in the breeding nursery, with special precautions to prevent contamination by pollen from outside sources and to keep the level of inbreeding as low as possible.

Earl R. Leng, Professor of Plant Breeding and Genetics, does research on improvement of corn, with special emphasis on the inheritance of economically important characters.

A continuing response

Response to selection in all four strains was shown in the early generations of the experiment. Reporting on the first two years' work in Station Bulletin 55, Dr. Hopkins wrote: "All results thus far obtained indicate that it is possible to influence the composition of corn . . . by proper selection of seed. . . . "

L. H. Smith, who took direct charge of the experiment in 1901, reported in Bulletin 128: "It has been possible by selection and breeding . . . [to develop] two strains of corn . . . of which one is now almost twice as rich in protein as the other, and two other strains . . . one of which is now nearly three times as rich in oil as the other."

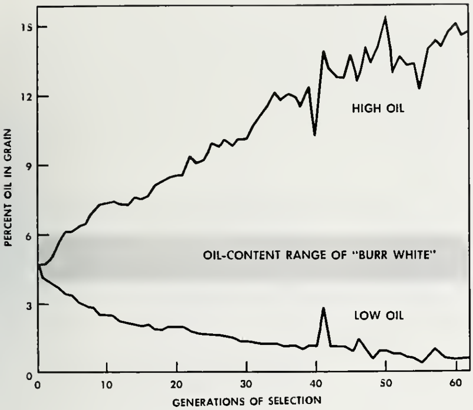
When C. M. Woodworth assumed direction of the experiment in 1925, the results of the first 28 generations of selection were again evaluated. Dr. Woodworth and his student, Floyd Winter, concluded that response to selection was still continuing in the "High Oil" and "High Protein" strains but had practically ceased in the "Low Oil" and "Low Protein" strains. They recognized however, that further information could yet be gained from the program and so it was continued.

During the depression and World War II, competition for funds and facilities raised serious questions about continuing selection in the "chemical strains." Although the actual growing of the strains was suspended from 1942 to 1944, seed was preserved and selection was resumed in 1945. The present author became responsible for field operations and data-processing in 1947, and took charge of the studies in 1951.

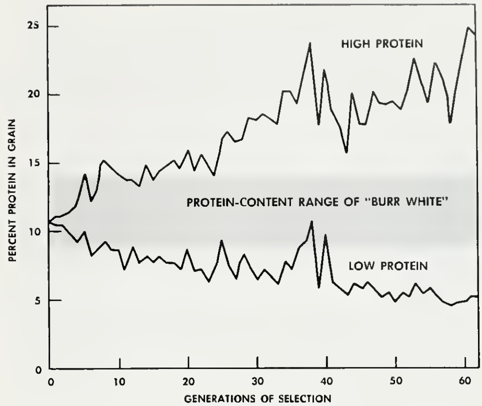
Oil and protein contents today

Now, after 63 generations of selection, it is obvious that the results of this experiment are of fundamental importance for studies of selection theory and evolution under domestication. From a "run-of-the-mill" open-pollinated dent corn variety, four selected strains have been developed which have chemical compositions unique in the world's great diversity of corn types.

As shown in Figure 2, the "Illinois High Oil" strain now averages about 15 percent oil, and the "Low Oil" strain less than 0.75 percent, as compared with 4.75 percent in the original "Burr White" strain. Besides these drastic changes in total oil content, the fatty acid ratios and resulting chemical characteristics of



After 62 generations of selection, the "High Oil" strain now has 15 percent oil in the whole grain, and the "Low Oil" strain has less than ¾ of 1 percent. (Fig. 2)



The "High Protein" strain has nearly 25 percent total protein content in the grain, and the "Low Protein" strain has about 5 percent protein. (Fig. 3)

the oil itself have been markedly changed.

Likewise, selection has resulted in a "High Protein" strain averaging nearly 25 percent protein, and a "Low Protein" selection whose grain barely contains 5 percent total protein (Fig. 3). The original "Burr White" variety had a protein content just under 11 percent in 1896. It should be noted that the additional protein in the "High" strain is largely of the high-zein type endosperm protein, which is not a balanced nutritional source of additional protein in feeding most farm animals.

Significance of experiment

From a practical standpoint, none of the four "Illinois Chemical" strains can be grown successfully as a farm crop. Inbreeding during the long period of selection, as well as disregard of all characters other than specific chemical content, has resulted in loss of vigor and poor yielding ability. Stalk quality and disease resistance are not high in the selected strains. Yet the "High" strains have some potential value as source material for improving the oil or protein content of standard corn types, and in fact have been used this way by Dr. Woodworth and R. W. Jugenheimer.

The chief value of the experiment is that it demonstrates the effects of long-continued selection toward specific objectives. In fact, this is the only controlled selection experiment with an economically important crop plant which has been continued over a large number of generations. Moreover, selection has been practiced for very specific traits, which can be evaluated accurately; experimental procedures have had very close continuity; and data have been recorded in a uniform manner over the entire period.

Some of the conclusions reached from this work, which have particular importance for breeding and selection theory, are:

1. Response to selection has been extremely great in all four strains.

2. Both oil and protein content in corn can be changed very rapidly by selection.

3. Response to selection has been irregular in rate, rather than steady. Thus prediction of specific response trends is very difficult.

4. Total variability of chemical composition has remained high in all four selected strains. Further response to selection is therefore possible, even after many generations of breeding.

The breeding system used is very much like the "recurrent selection" systems now being used by many plant breeders. The "Illinois Chemical" experiment therefore provides evidence that such systems can be very effective in improving specific characters in corn.

Among others, D. E. Alexander of our Department of Agronomy is using this experience and information to plan a new breeding program for high-oil content in corn. He has already found that high-oil selections with good physical appearance and excellent disease resistance can rapidly be obtained by recurrent selection. With the current interest in corn oil for human nutrition, it is quite likely that Dr. Alexander's work will be of considerable importance in the immediate future.

Dr. Hopkins, Dr. Smith, and their associates could scarcely have dreamed, in the early years of this century, that their "Illinois Chemical" strains of corn would still be undergoing selection in the 1960's, or that breeders and geneticists the world over would be interested in the theoretical implications of their work. The importance of the results which have been achieved is a testimonial to the soundness with which these early research workers planned, and to the judgment of those who continued the experiment when its value was not readily apparent.

One year's research provides partial answers to farmers' questions

RAISING SWINE ON SLOTTED FLOORS

C. K. SPILLMAN and A. H. JENSEN

After a year's research at the Moorman Swine Breeding Research Farm at Urbana, we have some partial answers to questions that farmers are asking about raising pigs on slotted floors.

Some of the points we are investigating are the pen space per animal, ventilation requirements, labor needed for manure disposal, effect of manure-disposal method on environment of animals, and effect of temperature on performance.

An overall objective at the Moorman Farm is to compare the performance of animals housed in different buildings. Several types of houses have been built, using various methods of construction. Each building was designed to house 15 litters. Size of the buildings was determined by the type of housing provided.

Design of house

As far as possible, we drew upon past experience when building the slotted-floor house. When experience could not provide an answer, we had to fall back on guesswork.

The shell is a wood rigid frame. Galvanized steel siding is on the outside, while the inner lining is fiber board covered on both sides with aluminum foil. The roof and side walls have 3 inches of fiberglass insulation.

Outside dimensions are 24 by 64 feet. Cross-foundation walls run across the building every 8 feet, forming eight manure pits under the slats (Fig. 1). Each pit is 7½ feet wide by 23 feet long and holds the manure from two pens directly above it. (Feed storage takes the place of one pen above one of the pits.)

C. K. Spillman, formerly Assistant in Agricultural Engineering, is now on the staff of Michigan State University. A. H. Jensen is Associate Professor of Animal Nutrition.

Slats are made of concrete. A high-strength concrete mix was used to provide resistance to urine and other corrosive elements. The slats are 8 feet long and are 5 inches wide at the top, tapering to 3 inches at the bottom. They are spaced 1 inch apart, with the ends resting on the cross-foundation walls.

Pens are about 8 by 10 feet. Partitions between them are made of 2-inch lumber. Each pen provides a maximum of about 10 square feet per animal, assuming a litter size of eight pigs. Sliding partitions make it possible to vary the amount of space to a minimum of about 2 square feet per animal.

Ventilation

The ventilation system can be changed to meet the animals' needs at different seasons of the year. Two 10-inch fans that bring air into the building are located in each long side. Each fan is equipped with a baffle to direct the incoming air along the surface of the wall. A 14-inch exhaust fan is at one end of the building and an 18-inch fan at the other end. Both exhaust fans have motor-operated shutters. Each pen has an inlet door, at floor level, that measures 6 inches by 4 feet and is hinged at the top.

During the first winter of operation, the ventilation system was adequate. The animals appeared comfortable and their rate of gain was good. After the manure-water mixture had been in the pits for a period of time there was an offensive odor in the building. The odor could be controlled by the ventilation system if the pits were emptied every 3 to 4 weeks.

Ventilation was not adequate for summer conditions although the calculated airflow of more than 50 c.f.m. per animal, providing an air change every 2 minutes, is normally considered good design. The solid partitions around the pens may have restricted air movement to the point where the animals did not get enough fresh, dry air.

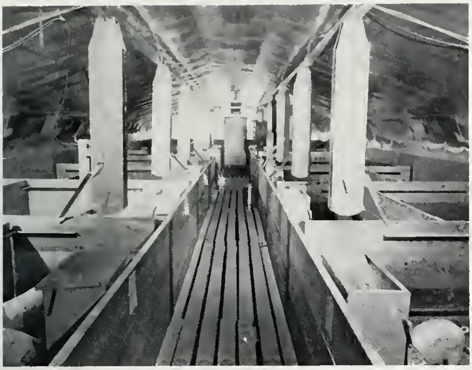
Cross-foundation walls support the ends of the slats and divide the area under slots into sections 7½ feet wide and 23 feet long. (Fig. 1)

Next summer the plan is to provide open partitions on two sides of the animals, and possibly install more ventilating equipment.

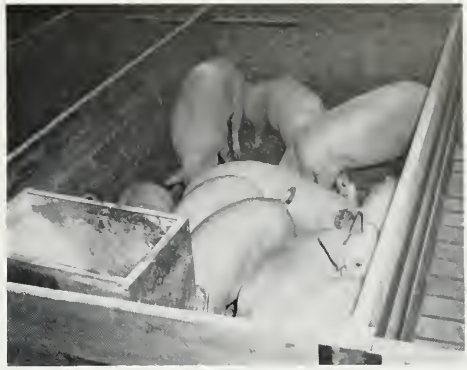
Floor space

According to previous studies at the Illinois Station, 4 square feet of floor space is adequate for a pig from 40 to 110 pounds in weight. Pigs between 110 and 200 pounds have gained faster with 8 square feet per animal.

The amount of space needed for maximum performance may vary



Interior view of building shows general layout of pens and the sliding partitions that permit variation in the amount of floor space for each animal. (Fig. 2)



Each of these 130-pound pigs has 4 square feet of floor space. Two weeks later they covered the entire floor when they were all lying down. (Fig. 3)

with temperature. In the first year's experiments on the Moorman Farm, space restriction affected pigs on slotted floors more in hot weather than in cool weather (Table 1).

Given a certain amount of floor space per pig, the number of pigs per pen may affect the degree of stress. In one trial with 120- to 150-pound pigs, all animals were allowed 4 square feet of space, but the number of pigs per pen was varied. Gains were markedly less when pigs were kept 16 to a pen than when there were eight or four pigs in a pen (Table 2).

Labor requirements

A distinct advantage of the slotted floor is the reduction in labor needed to remove waste material. A comparison was made during a 113-day period of the time spent cleaning waste in the slotted-floor building and in a building with a solid concrete floor. Each building had 42 pigs — seven in each of six pens. The solid-floor building required an average of 17 minutes a day; the slotted-floor building, 1¼ minutes. If you allow an 8-hour day for cleaning under the slats at the end of the 113-day period, about 4¼ minutes would be added to the average time spent per day.

An added advantage of the slotted-floor building is that it can be cleaned at one's convenience whereas a regular schedule of cleaning is usually desirable in a solid-floor building.

Breakdown of organic matter

The 1-inch slot and 5-inch slat have been effective in allowing manure to drop into the pit below. The pit is normally filled with water shortly after it is emptied. The manure-water mixture is held for varying periods of time. During this holding period anaerobic bacteria start breaking down the organic matter.

The breakdown of organic matter occurs in two stages. During the first stage saprophytic bacteria use the organic matter as their food source, converting it into organic acids and water. A second group of organisms, known as the methane formers, use the organic acids as a food source and give off methane. Carbon dioxide is given off during both stages of breakdown. Other organisms are also present, producing varying amounts of other gases such as hydrogen sulfide and ammonia. Carbon dioxide and methane account for most of the gas produced.

Researchers from the Agricultural Experiment Station have been cooperating with sanitary engineers in studying the breakdown of organic matter. Some work has been done on the gases produced, but a more elaborate technique than we've been using is needed to determine all the various components. We hope to start a study to determine at what levels the different gases affect production or become toxic to swine.

When the gases produced by the microorganisms are determined and the effects of these gases are known, a ventilation system can be designed to provide the proper environment. Information obtained on the amount of breakdown and the characteristics of the waste will be useful in designing indoor and outdoor lagoons.

Table 1. — Effects of Floor Space and Season on Pig Performance

Season	Sq. ft. per pig		Difference in gain
	4	8	
	Av. daily gain, lb.		*Pct.*
Winter[a]	1.60	1.76	10
Summer[a]	1.20	1.48	23

[a] Pigs weighed 120 to 170 pounds in winter; 135 to 190 pounds in summer. Average of two pens.

Table 2. — Effects of Floor Space and Number of Pigs per Pen

Weight of pig	Pigs per pen[a]		
	4	8	16
	Av. daily gain, lb.		
30 to 120 lb.	1.39	1.44	1.35
120 to 150 lb.	1.39	1.46	1.05

[a] Four square feet of floor space per pig; summer season. Average of two pens.

How do we measure the IMPORTANCE OF AGRICULTURE?

R. G. F. SPITZE

THE RAPID changes occurring in agriculture have so many economic, political, and social implications that increasingly the question is raised: How important is agriculture in our modern world?

Table 1. — United States and Illinois Farm Production, 1920-1961[a]

Year	Total gross value of farm production U. S.	Ill.	Pct. that value of U. S. production is of GNP[b]
	million dollars		
1920	16,595	...	18.7
1930	11,163	...	12.3
1940	11,319	...	11.3
1950	33,297	1,943	11.7
1960	38,263	2,134	7.6
1961	40,150	2,434	7.7

[a] Sources: U. S. Dept. Agr., U. S. Dept. Com., Council of Economic Advisers.
[b] GNP = gross national product, or total value of all goods and services produced.

To discuss the importance of agriculture, we have to define "agriculture" and "importance," for obviously these words mean different things to different people. In this paper, "importance" is discussed in economic terms and "agriculture" is considered as (1) producer, (2) purchaser, and (3) employer. Agriculture as farming and as off-farm agricultural industry will be considered separately.

Producer

Agriculture as producer can be viewed first in terms of farm production of raw food and fiber; second in terms of off-farm production of marketing services and of supplies and services needed in the farm business.

Total value of farm production in the United States and in Illinois is given in Table 1. In the diagram appearing below Table 1, production costs and the value of marketing services, plus the value of other nonfarm production, are added to net farm income to give the gross national product (GNP). The $20.3 billion representing total net income to the farm population is 4 percent of the GNP and is one measure of farm people's contribution, in goods and services, to the total economy.

Total net income to farm population	$20.3 bil.	—	Off-farm, nonmoney, farm wage income, government payments	$12.2 bil.	=	Net farm income from sales	$8.1 bil.
Net farm income from sales	$8.1 bil.	+	Farm production costs	$27.1 bil.	=	Gross farm product sales	$35.2 bil.
Gross farm product sales	$35.2 bil.	+	Marketing services	$65.1 bil.	=	Consumers' food and clothing expenditures	$100.3 bil.
Consumers' food and clothing expenditures	$100.3 bil.	+	Other personal expenditures, corporation reinvestment, etc.	$420.9 bil.	=	Gross national product	$521.2 bil.

Farm and off-farm agricultural production in comparison with U. S. gross national product, 1961. (Sources: U. S. Dept. Agr., Council on Economic Advisers.)

Purchaser

Estimated purchases by Illinois farm families for their production and consumption in 1960 are presented in Table 2. According to the U. S. Department of Commerce, total personal income of farm and nonfarm people in Illinois for the same year was $26,425,000,000.

Too few data are available to measure purchases by off-farm agricultural industries (firms that provide farm production supplies, farm

Table 2. — Illinois Farm Family Purchases, 1960[a]

Purchase	Value
Farm production	
Feed	$ 243,500,000
Buildings, vehicles, machinery, estimated	241,300,000
Repairs and operations[b]	228,300,000
Livestock and poultry	210,000,000
Taxes on farm property	145,700,000
Rent to nonfarm landlords	129,700,000
Miscellaneous services and supplies	115,300,000
Fertilizer and lime	97,100,000
Hired labor	94,000,000
Seed	36,700,000
Interest on farm mortgage debt	25,700,000
Total	1,567,300,000
Farm family consumption[c]	
Food	128,000,000
Medical care	90,000,000
Household operation	80,000,000
Transportation	54,000,000
Clothing	51,000,000
Furnishings and equipment	51,000,000
Housing	51,000,000
Recreation	50,000,000
Education	17,000,000
Personal care	13,000,000
Other (church, welfare, gifts, etc.)	108,000,000
Total	693,000,000

[a] Sources: U. S. Dept. Agr., U. S. Census Bureau, Ill. Coll. of Agr. Figures do not reflect use of farm family income for savings and income taxes.
[b] Almost half this item was for fuel, according to previous estimates.
[c] Data derived by crude estimating. Size of any particular expenditure is not as useful as overall picture of consumption purchases.

consumer goods, and marketing services). However, the probable impact of such purchases on the economy is suggested when we consider the number of people employed by these industries.

Employer

Even with a declining employment in actual farming, increasing numbers of workers are needed to bring food to the consumer and to provide the expanding volume of supplies needed by commercial farmers. When one tries to enumerate these workers, however, one is faced with the indefiniteness of the word "agriculture." "Farm workers" can be rather accurately defined, but where is the line drawn for workers in "agricultural industries"? Do these industries include only manufacturing, or do they include retailing and service businesses as well?

In Table 3, "agricultural industry" includes all firms processing and selling farm products, manufacturing farm equipment, and supplying services to farm people. Workers in these occupations, plus those on the farm, total 31 percent of all workers in Illinois, making it apparent that agriculture, viewed in this way, is an important part of our economy.

Table 3. — Employment in Farming and Agriculturally Related Industries, Illinois, 1961[a]

Type of employment	Number
Total employed	3,728,800
Nonagricultural industry	2,557,500
Farm and agricultural industry	1,171,300
Farm workers	246,000
Manufacture of agricultural products	
Food, tobacco, kindred products	129,500
Apparel and textiles	52,500
Leather products	19,100
Paper products	34,000
Wood products	11,800
Manufacture of farm equipment	26,800
Retail food	81,500
Retail apparel	38,800
Others (buildings, appliances, amusement, government, fuel, finance, etc.)[b]	531,300

[a] Sources: U. S. Dept. Agr., Ill. Dept. Labor.
[b] Data estimated as that portion of all employment which is related to the manufacturing and distributing of any product sold by farmers or purchased by the farm family.

R. G. F. Spitze is Associate Professor of Agricultural Economics.

Extension Service Conducts Workshops On Farm Business Problems

R. B. SCHWART

THIS WINTER almost 2,000 farm families are participating in workshops designed to help solve problems of farm management, credit, and financial structure of the farm business.

These workshops are sponsored by the Cooperative Extension Service and are conducted by the five area advisers of the Farm and Home Development Program, the farm advisers, and the state staff.

About 90 workshops are being held in 80 counties. They consist of either five 2-hour weekly sessions or three 4-hour sessions.

Purpose and subject matter

The workshops were organized because every year it's taking more management ability and more capital to farm efficiently and meet present-day standards of living. In fact, agricultural leaders believe that the acquisition and management of capital is one of the major problems facing farmers in the decade ahead.

The problem is becoming increasingly complex. On the one hand, new technology tends to encourage expansion of the farm business. On the other hand, higher prices and cash costs are forcing many farmers to be cautious about expanding their operations.

Specifically, the objectives of the workshops are: (1) to give farm families more knowledge and tools for organizing their farm and home business; (2) to help farmers make decisions on the most effective use of capital and credit; (3) to help farmers develop the necessary tools (such as financial operating budget and net worth statement) for presenting their credit needs to lending institutions; and (4) to help farm advisers in counseling with farmers on management and credit problems.

Topics covered in the workshops include the following:

1. What has happened to agriculture and what lies ahead for farmers.
2. Family goals and the income needed to achieve these goals.
3. Developing a long-time farm plan to meet family goals and needs.
4. Changes needed to improve farm efficiency and achieve family goals.
5. Financing the farm business: developing an annual financial plan, preparing a net worth statement, and studying the types of credit needed as well as procedures for obtaining credit.

The farm and family business management program owes much of its success to research in agriculture and home economics. Data from the Illinois farm management record program and the detailed cost record studies made it possible to develop short-cut procedures for comparing alternative crop and livestock systems.

The Illinois home account record project contributed valuable information for the family economics section of the program.

Procedures for helping farmers with their credit problems were developed through research work in farm credit and through the cooperative working relationship of the University of Illinois and various credit agencies.

Cooperation necessary

Agricultural credit institutions, and other county farm agencies have been asked to cooperate with Extension councils and farm advisers in enrolling farm families. The continuing success of the program depends on the support of all organizations providing agricultural supplies and services.

R. B. Schwart is Associate Professor of Farm Management Extension.

Improving Rural Educational Opportunities

K. E. GARDNER

IT HAS BEEN STATED that one function of a college is to tell people not what they want to hear, but rather what they ought to hear. Some of the following comments may not be overly palatable to everyone; nevertheless, they may help us think through some of the serious educational problems in rural Illinois.

Education still remains the best single method for a man to lift himself by his own bootstraps. As someone has said, "Education is too important to leave to the educators alone." Every rural citizen must become informed about our educational shortcomings and then pledge himself to work for improvement. What are some of these problems?

Grade school and high school teachers' salaries are low in rural areas. The best available teachers naturally gravitate, in time, to the better-paying positions, which are usually in the suburbs. This means a poorer educational opportunity for rural youth. There is no magic in getting better schools. If we want them we have to pay for them, denying ourselves some luxuries if necessary. There are worse things than school taxes.

Our extremely elaborate gymnasiums may provide for excellent adult and youth entertainment, but good teachers are more essential. Far too many rural school teachers have not graduated from college and are teaching with temporary approval. This, again, is a result of salary scales.

An improved intellectual attitude is needed. If rural families, or urban, do not convince their children of the importance of learning, then these children will not struggle to obtain the maximum education which their intellectual capacities make them capable of achieving. The home must be a library and a study hall, serving as a continuation of the school house or the local Carnegie Library for evenings, weekends, and vacation periods. What kinds of books and periodicals are "lying around" rural homes?

Poor grammar in the home may not seriously damage the economic success of established farmers or businessmen, but it can permanently handicap the young son or daughter whose ears are constantly bombarded by incorrect pronunciations, ungrammatical colloquialisms, and inadequate vocabulary usage. Today's farmers, as they participate in solving the new rural-urban community problems, are finding that they cannot exert their proper influence without adequate speaking ability coupled with an aptitude for well-written exposition. This will be even more true of the businessman-farmer of tomorrow.

School curricula should be studied. Rural or, for that matter, urban students can graduate from the typical Illinois high school with only a minimum exposure to courses which are demanding and which develop the cultural and scientific storehouse of the student. This is the age of science and technology, and the student who misses the opportunity to study science in high school may short-change himself for the rest of his life. Our society demands a certain basic level of information in science today to understand even the daily newspapers.

Courses in physics, chemistry, mathematics, biology, and the like are more important than ever before. The "general science" course so frequently taught in Illinois high schools requires vigilance to keep it at a high level. Being undefined, it degenerates readily.

Some students avoid a heavy diet of science courses and additional mathematics because they fear they may lower their grade average, and perhaps fail to make the honor roll. If the honor roll does this in our educational program, we are better off without it. It need not do this, but it can.

In addition to science, our students need history, economics, and training in both written and spoken English.

Students can, and many do, carry more than the all-too-common four units each year. Typing, for example, can be a useful skill for all high school students, but it should be taken as a fifth subject rather than as a replacement for an academic one.

Higher education needs support. Rural youth over the United States are entering colleges at less than half the rate of urban youth. This is also true in Illinois, one of the leading agricultural states, even though our state in the 1850's was a true leader in establishing the Land Grant system.

High real estate taxes, rapidly increasing costs of agricultural production, and relatively low prices for agricultural products—all these help explain why many qualified farm boys and girls feel they cannot afford to go to college.

This leads to a serious question, "Can capable rural youth afford *not* to go to college?" Some 80 percent of them will have to compete with urban youth in the urban labor market.

Another pertinent question is, "Are rural young people willing to make sacrifices in immediate income after high school?" While a college education is becoming increasingly expensive, a significant percentage of college students in agriculture still earn over half the costs of their college education while they are attending school.

In the final analysis, it is the attitude of the boy's or girl's parents and associates toward college which will largely determine whether rural youth decide that "college is worth the effort."

K. E. Gardner is Associate Dean of the College of Agriculture.

RESEARCH IN BRIEF

Everbearing Strawberries for Illinois Home Gardens

Everbearing strawberry varieties appeal to the home gardener because they produce in the spring and early summer and again in the fall up to the first frost. They also have ornamental value when planted along walks and foundations, for example, or in a strawberry barrel or pyramid.

In general, everbearing strawberries are not recommended for commercial production, although they can be grown for limited local sales. None of the everbearers tested so far can equal the best spring-fruiting varieties in yield and quality.

For an average family garden, at least 50 everbearing plants would be needed to provide enough fresh berries. Under ideal conditions, the better-producing varieties may yield as much as 1 quart of berries per plant in the spring, and 1 pint in the fall. Yields are usually lower in southern Illinois because of the hot summers.

During the past two years, 13 varieties have been tested at the Dixon Springs Experiment Station and at Urbana. Following are brief descriptions of the best ones.

Ozark Beauty is very firm, has very good flavor, and is attractive, although the berries are somewhat seedy. It has been a top producer in trial. Recommended for both northern and southern Illinois, this variety has been outstanding compared with other everbearers tested.

Streamliner is medium in firmness, attractive, only fair in flavor, and a good producer. It is recommended for the entire state.

Gem (Brilliant, Superfection) is small, soft, only fair in flavor, and a good producer. It is recommended for the entire state.

20th Century is medium in firmness, somewhat rough in shape, only fair in flavor, small to medium in size, and a fair to good producer. It is recommended for northern Illinois only.

Ogallala is small, soft, has fair flavor, and is a good producer. It is recommended for northern Illinois only.

In Illinois everbearing strawberries are best grown in a hill system with the plants spaced 1 foot apart. All runners are pinched or cut off as they develop. Mulching conserves soil moisture, keeps the berries clean, keeps down weeds, and helps make an attractive planting. Most commonly used mulches are crushed corncobs, sawdust, and black polyethylene plastic. Sawdust and corncobs are often free for the hauling and are easy to apply. However, a little extra nitrogen must be applied when they are used. Black plastic is inexpensive, but is a little harder to use than corncobs or sawdust. Also, in severe winters plants mulched with plastic may be injured or killed.

Everbearing strawberries should be irrigated during dry periods in the summer, particularly in the southern part of the state. Otherwise fall production can be quite disappointing. — *J. W. Courter and C. C. Zych*

Ground corncobs have been used to mulch these everbearing strawberries grown in the hill system.

Activity of the Thyroid Gland in Young Pigs

The structure and activity of the thyroid gland has been the subject of numerous studies in many animals and man. However, little systematic work has been done on the thyroid gland in the pig. Reports indicate that limited correlation exists between the rate of thyroid secretion and the growth rate in pigs.

Different procedures have been used to measure thyroid activity. The basal metabolic rate indicates the effect of thyroxin (an iodine-containing secretion of the thyroid) on oxidation processes in the body. Another indication of thyroid activity may be obtained by measuring the iodine bound to the serum protein. This is because the thyroid hormone circulating in the blood is linked to the globulins of the blood serum. A third measurement is provided by the ability of the thyroid gland to concentrate iodine.

Finally, the thyroid gland's activity may be reflected in its microscopic structure. This would include the size of the follicles (small secretory areas of the thyroid); the height of the follicular cells; the amount of tissue between the follicles; and the appearance of the colloid or gelatinous material which includes thyroxin as well as other compounds and which is found in the follicles.

In the College of Veterinary Medicine pigs were injected with radioactive iodine (I^{131}) to measure the uptake of iodine by the thyroid gland. We found little correlation between activity of the thyroid gland, measured in this way, and either cell structure or colloid characteristics. We did, however, find a close correlation between thyroid activity and the formation and growth of the follicles. From birth to 8 weeks of age, while follicles were forming, thyroid activity increased slightly. After this, while the thyroid follicles were increasing in size, activity, in terms of I^{131} uptake, gradually decreased. —*M. N. Jamdar, L. E. St. Clair, and E. F. Reber*

Clothing Comfort in Hot, Humid Environments

In hot, humid weather, are you going to be any more comfortable wearing untreated cotton than water-repellent cotton or Orlon? To help answer this question, five women wore suits of the three fabrics while seated in an environment of 94° F. and 80 percent relative humidity. Because of the differences in fiber content and finish, the fabrics differed in water-absorptive and water-adsorptive capacity, even though they were all of similar construction.

None of the subjects said that they were hotter in one fabric than in another. Nor were there differences in total weight losses, evaporative weight losses, rectal temperatures, or times of onset of sweating.

There were differences, however, in weight gains of the clothing and in the amounts of liquid moisture on the skin after the period in the environment room. These differences were especially marked after the women had been perspiring freely. Even though the women did not feel warmer in the water-repellent and Orlon suits, they did feel more uncomfortable because these fabrics did not remove as much moisture from the body as the untreated cotton.

Clothing can allow the escape of perspiration from the skin in two ways: (1) Liquid water can move by capillary travel (wicking) into the clothing and be evaporated from the fabric. (2) Water vapor can be diffused from the skin through the clothing. This study suggests that, for the three fabrics tested, the second method played a larger role than the first one. — *Ruth Galbraith*

Physical Punishment Makes Children Aggressive

The old adage, "Spare the rod and spoil the child," has long been questioned by child psychologists. Their scepticism seems justified in view of a recent study conducted at the Child Development Laboratory of the Home Economics Department.

Nursery school children were rated by their teachers on a number of characteristics. Was the child tense and anxious? Did he bite his nails or have other nervous habits? Was he too dependent, "hanging around" the teacher too much? Did he approach new activities with enthusiasm and optimism? Did he fight a lot?

Mothers of the children were then interviewed about their child-rearing practices, especially the methods used in getting the child to obey. For some mothers, spanking was the most common discipline technique. Others used tangible rewards with a system whereby the child could earn money, points, or gold stars. Some mothers deprived their children of privileges to get them to mind; they would take away a prized toy or isolate the child from other children or the family.

By far the most commonly used method was the withdrawal of approval. Typically the mother would indicate her disapproval by simply telling the child that she didn't like a particular kind of behavior. This was extremely effective when coupled with approval for desired behavior — for example, "Mama likes the way you asked me to pass the mashed potatoes." Experts believe that this technique works best.

The experts' beliefs were borne out when the children's behavior, as rated by their teachers, was viewed in light of the type of discipline used. The most tractable children had been disciplined by the withdrawing-approval and giving-praise technique. However, the most significant result statistically involved the use of physical punishment. Children who were spanked a lot were consistently rated as aggressive. This was particularly true of the ones who, in addition to being spanked a lot, were not allowed to express aggression toward their parents. The child learns from his parents that punitive measures are an acceptable form of self-expression and then directs his aggression against his classmates.

The study did not indicate that sparing the rod necessarily spoils the child. But it did show that parents who relied principally on the rod could expect to have aggressive children. — *Jim Moore*

Centennial of an Idea — and of a Tree

Many people have marveled at the venerable age of 250 or 300 years that oaks sometimes attain. Few, however, have emphasized any rapid growth rate for these trees.

In the Farm and Home Science Show last fall, the cross-section of a 100-year-old bur oak was used to dramatize both the growth of the tree and the beginnings of some important agricultural programs.

Annual growth rings were marked to show how big the tree was at the time of these events: **1862**, the Land Grant college system and the U. S. Department of Agriculture were established. **1887**, the Hatch Act provided for state agricultural experiment stations. **1914**, the Smith-Lever Act established the Cooperative Ex-

tension Service. **1926,** forestry extension work was begun in Illinois. **1938,** the Department of Forestry was established at the University of Illinois. **1958,** professional forestry training was begun at the University. **1962,** centennial of the Land-Grant Act was celebrated.

Through reasonable assumptions, it was possible to develop values for a representative tree on the selected dates, as shown below:

Year	*Volume*	*Value*[a]	*Value/ MBM*
1862....	none	none	none
1887....	0.08 st'd cds	$ 0.09	none
1914....	281 bd. ft.	7.73	$27.51
1926....	417 " "	17.14	41.10
1938....	521 " "	24.07	46.20
1958....	946 " "	62.53	66.10
1962....	1,020 " "	71.50	70.10

([a] According to 1962 prices; value on stump plus margin for profit and risk.)

The sharp increases in value reflect the importance of quality and of tree size as an essential element of quality. The tree butt was 36.5 inches in diameter, inside bark. — *L. B. Culver*

Crimson — a New Color of Tomato Fruits

Color in red tomato fruits is conditioned by the total amount of carotenoid pigments present as well as the ratio of the red pigment, lycopene, to the yellow pigment, beta carotene.

Since 1960 researchers in the Department of Horticulture have been analyzing the carotenoid pigments in a breeding line of tomatoes which was obtained from Canada, the materials having originated in the Philippines. Fruits had been reported to be "bright red" and have since been described as crimson. The analyses have shown that, in crimson fruits, the ratio of total pigments (which are largely lycopene) to carotene is increased by a slight reduction in carotene content.

Previous research at Illinois had demonstrated that another color type, called high pigment, has about twice as much lycopene and carotene as standard varieties. A disadvantage of this type is that the plants often lose a great many leaves, with the result that exposed fruits usually do not develop a good red color. Heat inhibits lycopene synthesis but has little effect on the inherently high level of carotene.

It was reasoned that a combination of the high pigment and crimson characters might alter the red-yellow color ratio. Appropriate crosses were made, and the results this year appeared to be as expected. A number of plants were classified in the field as high pigment-crimson. Samples of field-ripe fruits were analyzed for carotenoid pigments and compared with a standard variety, Kc 146, with the following results:

Variety or type	*Total pigment*	*Carotene*	*T/C ratio*
	(mg. per 100 gm.)		
Kc 146.........	9.8	.28	35
Crimson........	7.5	.14	54
High pigment...	15.5	.76	21
High pigment-crimson......	15.3	.24	64

The high pigment-crimson combination apparently has the same high quantity of total pigments as the high pigment lines, but has the carotene level of a normal tomato. It should now be possible to produce varieties with the high pigment-crimson characteristics that will develop superior red color under normal conditions, and even good color under adverse conditions. It should also be possible to spread tomato harvesting over a longer period, and still have acceptable color in processed tomato products. This would be of considerable value in tomatoes adapted to mechanical or "one-shot" harvesting. — *A. E. Thompson*

Testing Wood Preservatives by the Stake Method

Through the years many accelerated tests have been devised to give information on the permanence of treated wood. However, none of these tests has been accepted with complete confidence. It is impossible to duplicate in test the varying conditions of exposure that occur in actual service.

A test that comes close to duplicating the conditions of actual service has been used by the Department of Forestry since 1947 to test 34 formulations of oil-borne preservatives. This test involved treating 1,400 stakes, 2 inches square, 2 feet long, and pointed at one end. They were set in the ground at the Dixon Springs Experiment Station, in a location especially favorable to decay and insect attack.

The small cross section of the stakes meant a high ratio of surface area to unit volume. This may have caused a rapid leaching and volatilization of the preservatives, thus reducing the time needed to bring about destruction. Results were probably influenced by toxicity of preservatives so that the test was not one of permanence alone.

Indications from these results are that properly treated material of commercial size will last considerably longer than small specimens used in a stake test. — *K. R. Peterson*

Some of the 1,400 stakes that were set in the ground at the Dixon Springs Experiment Station nearly 16 years ago to test the effectiveness of 34 wood preservatives.

FARM BUSINESS TRENDS

As shown by the chart below, hog prices fluctuated widely in the 1950's but were unusually stable in the first three years of the 1960's. If prices continue to be relatively stable, and this seems likely, farmers will be able to make some profitable changes in their production and marketing methods.

The big price swings of the 1950's were caused by several factors including: (1) the Korean War, (2) large differences in the sizes of the fall and spring pig crops, and (3) marked changes in production from year to year. In a sort of "vicious circle," the big price changes in turn helped to bring on the large variations in production.

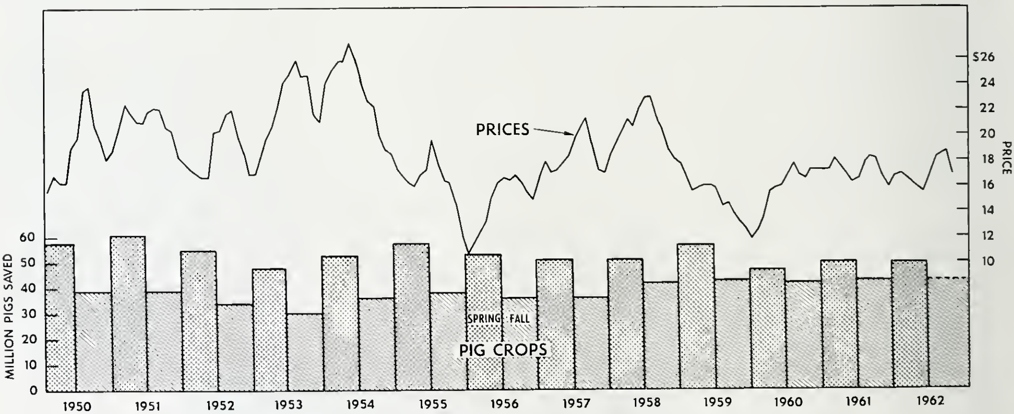
Prices went far above $20 for several months twice in the 1950's — once in 1954 and again in 1958. Each time farmers responded with excessive increases in production and prices dropped below the $12 line.

The worst break of hog prices on record was that from April, 1954 to December, 1955. In just 20 months prices dropped from over $26 to under $11. The biggest factor in this unfortunate experience was the fact that farmers had increased the pig crop from 30 million head in the fall of 1953 to 58 million head in the spring of 1955. Farmers, and prices, repeated this performance in a slightly modified manner in 1957-1959.

By luck or by plan hog production and prices have been unusually steady since 1959. Both year-to-year and season-to-season changes have been small.

With this new stability there is no longer a big advantage in rushing hogs to market to beat price declines. Instead, there are new opportunities for profit. For example, producers can cut costs by limited feeding. This practice has the further advantage of producing leaner and, consequently, more valuable carcasses.

Farmers with little equipment can use a one-litter system, with sows farrowing in the late spring when the weather is warm. Pasture can be used extensively for both breeding stock and growing pigs. The hogs can be finished on low-cost new corn. They can also be used to save many bushels of corn that would otherwise be lost in the corn fields. — *L. H. Simerl, Professor of Agricultural Economics*



Spring and fall pig crops in the United States, and monthly average prices at eight midwestern markets, 1950-1962.

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ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

IN THIS ISSUE

Cholera-free hogs are the aim of Macoupin county swine survey (page 12).

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ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

CONTENTS

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DEANS OF THE COLLEGE OF AGRICULTURE: EUGENE DAVENPORT

In 1895, the College of Agriculture consisted of nine students, three instructors, and a few ramshackle buildings. The condition of the College appeared so hopeless that Andrew Sloan Draper had accepted the presidency of the University the preceding year with the understanding that he would not be held responsible for any lack of progress in the College of Agriculture.

But the situation was not as bad as it seemed. Public opinion, which, in Morrow's time, had been actively against the College and University, was slowly swinging the other way. What the College needed most at this period of its history was a leader: it found one in Eugene Davenport.

Davenport came to Illinois as second Dean of the College of Agriculture with valuable experience as a scientist, farmer, and administrator. Born in Michigan of pioneer parents in 1856, he had earned three degrees from the Michigan Agricultural College (now Michigan State University), later become professor of practical agriculture and director of the experiment station at that institution, and had founded and served as first president of an agricultural college in Brazil. Dean Davenport was a talented teacher, writer, and speaker, but his greatest contribution to the College was as an administrator. Under his leadership, the College of Agriculture at Illinois rose to a position of eminence among the agricultural colleges of the world. When he retired in 1922, the College had 175 faculty members and an annual registration of 1,200 students.

Davenport's contributions to agriculture and to education in general were widely recognized, and he received honorary degrees from Michigan State University, the University of Kentucky, Iowa State University, and the University of Illinois. Among the thousands of words written about him before and after his death in 1941, perhaps these words written by Anna C. Glover, his secretary for many years and later publications editor of the College, come closest to describing the true spirit of the man: "In all his work of administration, in his formation of policies, in his dreams of scientific accomplishment, he never forgot the human element. He saw nobility in honest labor, honest effort, and his courage and leadership were always linked with kindness." — *Richard G. Moores*

Growing Corn in a Killed Fescue Sod

A. R. GILMORE and G. E. McKIBBEN

THE PLOW-AND-PLANT method of seedbed preparation shows good promise in the hill section of southern Illinois. Besides giving satisfactory corn yields, it has helped stabilize the soil. The rough surface left in the operation is not as susceptible to erosion and water runoff as is the relatively smooth conventional seedbed.

The method has disadvantages too. Moisture is lost from the soil because of the large surface area exposed when the soil is turned, and the rough seedbed makes planting difficult. But these difficulties may be overcome by a method of seedbed preparation tested last year at the Dixon Springs Experiment Station in southern Illinois.

Why killed sod was tried

The usual procedure in the hill section of southern Illinois is to plant corn on the upland fields as part of a 5- to 7-year rotation. When a pasture needs renovation, a single corn crop is grown and the land is then reseeded to a legume-grass mixture.

It appeared to us that with such a rotation, planting the corn in a killed sod might be advisable. This procedure would leave not only a desirable surface mulch but also a good soil structure, which should eliminate the need for tillage operations. A potential drawback was that annual weeds and grasses might interfere with re-establishment of the pasture.

Three methods compared

To test our theory, we compared these methods of seedbed preparation, replicating the plots four times:

Plow, then plant in the tractor wheel tracks. Plots received a preemergence spray of simazine (2 pounds active ingredients) broadcast, and no cultivation.

Conventional seedbed. Plots were sprayed with 2,4-D once and cultivated once during the growing season.

Killed sod. Six weeks before planting, plots were sprayed with atrazine (4 pounds active ingredients). Plots were not cultivated.

The field used in the experiment had been in pasture for the previous 5 years. During the winter before the experiment began, the area was heavily grazed by cattle so that the fescue sod was only ½ inch high and water was standing in the deep hoof prints left by the cattle.

The cattle were removed on March 28 and atrazine was applied the next day to four ½-acre plots. Fertilizer was broadcast on all plots on May 3 at the following acre rates: ammonium nitrate, 700 pounds; 40-percent superphosphate, 200 pounds; muriate of potash, 200 pounds. To apply this amount with the equipment available, it was necessary to traverse the area six times with tractor-drawn equipment.

The plow-and-plant and conventional seedbed areas were plowed on May 7, and all areas were planted on May 9 with a tool bar unitized corn planter. Planting was for a population of 16,000 plants per acre in 40-inch rows. A 4-16-16 starter fertilizer was applied at a rate of 100 pounds per acre.

Conventional tillage plots were sprayed with 2,4-D ester (4 pounds to a gallon) on May 25 at a rate of ¼ pound of acid per acre. All plots received 400 pounds per acre of ammonium nitrate on June 7. This was applied by hand as a top dressing, as we did not want to disturb the atrazine- or simazine-treated areas with side-dressing equipment.

Effects of atrazine

On plots treated with atrazine, most of the vegetation was killed except grease grass, bull nettle, and common milkweed. When most competition to the grease grass was eliminated, it grew rapidly, reducing corn yields on the plots where it occurred.

A small area in one plot was missed with the sprayer when the herbicide was originally applied, and had to be hand-sprayed 2 weeks before planting corn. By this time, the fescue was nearly 3 inches tall, but

Four pounds of atrazine per acre killed the fescue sod (left) but did not kill grease grass, bull nettle, and common milkweed. Note deep hoof prints left by cattle. At maturity, corn grown on the killed sod plots (right) was as tall as corn on the other plots.

Table 1. — Total Number of Stalks and Barren Stalks Per Acre

Replication	Killed sod		Conventional		Plow-and-plant	
	Total stalks	Barren stalks	Total stalks	Barren stalks	Total stalks	Barren stalks
1	14,610	146	14,506	146	12,099	313
2	11,584	302	14,548	167	12,334	333
3	11,348	167	13,850	240	9,608	177
4	7,857	125	14,527	156	8,462	94
Average	11,350	185	14,358	177	10,626	229

the atrazine was very effective. In fact, the corn in this spot, which was outside the sampling area, appeared to be much above the average for the plot in color, height, and yield.

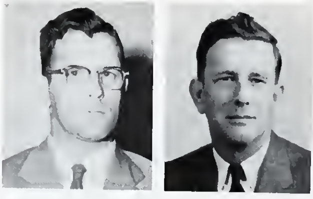
After the experiment was over, wheat was planted on the killed-sod plots to check the residual effects of the atrazine. According to preliminary observations, the carry-over effect does not appear to be of any consequence on our relatively light soils.

Plant populations and yield

Plant populations varied tremendously on all except the conventional plots (Table 1). By the end of the growing season, corn stalks were all about the same height, although some corn on the sod plots germinated nearly 2 weeks after that on the conventional plots.

In the first replication, yields were as high on the sod plot as on the conventional plot (Table 2). This was the only replication where plant population was the same for the two seedbed methods. It showed what can be produced if desired population and weed control are obtained under uniform conditions.

The plow-and-plant method produced acceptable yields on all replications even though plant populations were low. Because of the rough seedbed planted with this method, the population will probably never be as great as normally expected.



A. R. Gilmore (left), Assistant Professor of Forestry, and G. E. McKibben, Associate Professor of Agronomy, are both stationed at the Dixon Springs Experiment Station.

Soil condition

Method of seedbed preparation did not affect the temperature of the top 6 inches of soil, according to weekly measurements throughout the growing season. Soil temperature was 74° F. on May 10, the day after planting. The range during the growing season was between 70° and 82° F.

Before plowing in the spring, bulk density of the top 6 inches of soil averaged about 1.30. After plowing, it dropped to about 1.12 in the tilled plots, gradually increasing throughout the growing season until it reached about 1.18.

Plowing and cultivating loosened the soil so that more moisture was lost by evaporation, but aeration was improved where the soil was hard-compacted or was puddled. Where compaction was not a major problem, the soil in the killed-sod plots had a better physical structure, as well as a higher water-holding capacity, than the soil in the plowed plots.

All through the 1962 growing season, the killed-sod plots held more moisture than the others. The difference was especially marked by the end of a 2-week drouth which came during the last part of the growing season. Available moisture in the top 12 inches was 31 percent for the sod plots, 16 percent for the conventional plots, and 15 percent for the plow-and-plant plots.

This retention of moisture is a particular advantage in southern Illinois corn fields, where lack of soil moisture is often a critical problem.

Some changes need to be made

In an experiment conducted for the first time, one is bound to make mistakes which affect the outcome of the experiment. Our first mistake was applying atrazine too early. We believe now that the herbicide should be applied when the sod is about 3 inches tall, possibly right after planting. Another mistake was going over the area so many times with heavy equipment when water was standing on the soil surface. This definitely harmed the sod plots. A third error was failure to cover all of the seed in the sod plots to keep it from drying out or being eaten by birds.

These mistakes can be corrected. The problem that might become serious, however, is the grease grass. A way must be found to eliminate all competition to the corn when planting in a killed sod.

A promising method

All in all, planting in a killed sod has numerous advantages. Besides helping to control erosion and increase soil moisture, this method should cut machinery and labor costs. If the method is perfected, a small tractor can probably be used instead of a large, expensive one. Man hours should be considerably reduced, as it is believed that an area can be completely planted in one operation. A fertilizer spreader might be mounted on the front of the tractor, a modified corn planter immediately behind the tractor, and a trailer or some other system with a spray rig behind the planter.

Table 2 — Corn Yields According to Seedbed Preparation and Replication

Replication	Killed sod	Conventional	Plow-and-plant
	bushels per acre		
1	106	105	96
2	83	107	99
3	85	107	82
4	78	120	88
Average	88	110	91

A NEW SOURCE OF PHOSPHORUS?

Liquid phosphoric acid has been as effective as dry fertilizer on phosphorus-deficient soils in northern Illinois

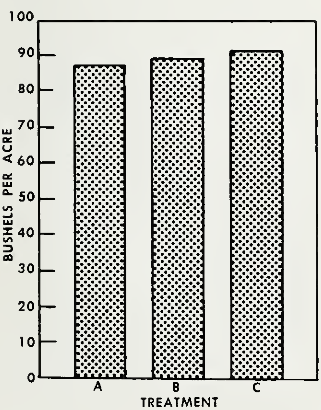
D. L. MULVANEY

FOR MANY YEARS farmers in the western states have been adding liquid phosphoric acid to their irrigation water to supply the phosphorus needs of their soils.

So far Illinois farmers have not used liquid phosphoric acid nearly as much as other phosphorus-supplying materials. Recently, however, they have been expressing interest in the direct application of liquid phosphoric acid for field crops. This interest may well increase for a number of reasons.

Recent and potential changes

The mere fact that more liquid phosphoric acid is becoming available can be expected to encourage interest in this material. Several new plants have been built in Illinois and other states to manufacture wet process phosphoric acid. An increased capacity for manufacturing this product may change the present price ratio between liquid acid and conventional sources of phosphorus.



Liquid phosphoric acid broadcast (Treatment B) or applied in the row (C) gave as good corn yields as superphosphate broadcast (A). (Fig. 1)

Table 1. — Corn Yields From Two Rates of Liquid and Dry Phosphorus Fertilizer

1961 treatment[a]		Yield, bu. per acre		
Carrier	Lb. of P_2O_5	1961	1962	Aver.
None	0	57.1	55.3	56.2
Liquid acid	20	64.7	63.2	64.0
Dry 0-46-0	20	62.3	66.2	64.2
Liquid acid	100	67.9	74.7	71.3
Dry 0-46-0	100	71.3	69.8	70.6

[a] Phosphorus was applied in 1961 only. All plots received 100 pounds of nitrogen per acre.

Another possibility is that phosphorus and nitrogen may be applied in a single once-over operation, using modified anhydrous ammonia applicators.

It can be expected that fertilizer manufacturers, distributors, and farmers will find the acid material easier to handle as more experience is gained and technology is improved.

Two kinds of acid

Two types of phosphoric acid are produced — a purified acid made by the electric furnace method, and a less pure, dark acid produced by a wet process system.

It is the production of the wet process phosphoric acid that is increasing rapidly. This process involves three steps: (1) Sulfuric acid reacts with rock phosphate; (2) the resulting acid is filtered to remove gypsum, leaving a solution that is about 32 percent P_2O_5; (3) the filtered acid is concentrated by evaporation to obtain material that is 54 percent P_2O_5.

The final product is thus the equivalent of a 0-54-0 fertilizer. A gallon of the acid weighs about 14.2 pounds and contains about 7.5 pounds of P_2O_5.

Satisfactory yield increases

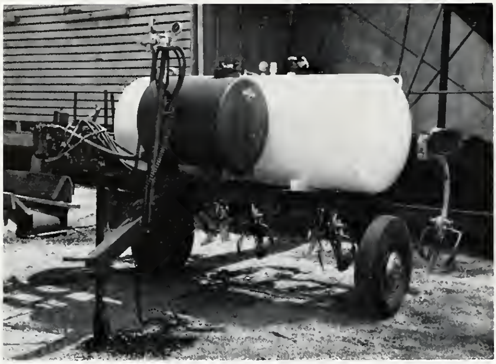
For the past two years, the liquid phosphoric acid has been tested on phosphorus-deficient soils on the Northeastern Illinois Agronomy Research Center in Will county. Soils were Symerton and Elliot silt loams. Phosphorus level was 15 according to the Bray P_1 test, pH level was 5.6, and potassium level was 270.

In one trial on replicated corn plots, the acid was compared to a commonly used dry form, triple superphosphate (0-45-0). Whether broadcast or row-applied, the phosphoric acid gave yields equal to those from the dry fertilizer (Fig. 1).

Another trial with corn involved two broadcast application rates (20 and 100 pounds of P_2O_5 applied as phosphoric acid and as dry 0-46-0). The materials were applied in 1961 and yields were compared in both 1961 and 1962.

Again the two carriers gave similar results (Table 1). Average corn yields were increased 8 bushels by the 20-pound rate and 15 bushels by the 100-pound rate.

D. L. Mulvaney, Area Agronomist for northern Illinois, supervises research at the Northern Illinois Agronomy Research Center near DeKolb, the Northeastern Agronomy Research Center at Elwood, and the Dixon Soil Experiment Field.




Experimental equipment used for applying anhydrous ammonia and liquid phosphoric acid in one operation. Close-up of soil injector tubes is shown at right. The rear tube delivered phosphoric acid; the front tube, anhydrous ammonia.

The two sources of phosphorus gave equally favorable results when broadcast and disked in ahead of winter wheat.

Applying two fertilizers

Other studies were made to determine the feasibility of applying liquid phosphoric acid and anhydrous ammonia at the same time. The experimental machine used in these studies is shown in Figure 2. It carried a conventional anhydrous ammonia tank, plus a smaller, plastic-lined one for the phosphoric acid. The acid was evenly distributed by a small wheel-driven pump and the two materials were injected into the soil simultaneously.

The machine was tried at the Joliet Soil Experiment Field, across plots where long-time fertility studies had been conducted. Before the application of phosphoric acid and anhydrous ammonia, corn yields on these plots ranged from about 50 to 100 bushels an acre, depending on the previous soil treatment.

On plots which had not previously received phosphorus, the phosphoric acid and anhydrous ammonia gave large yield increases (Table 2). No increase occurred, however, on plots that had an adequate supply of phosphorus from previous treatments.

Other experiments were conducted in 1961 and 1962 to determine whether yields were affected by the placement of liquid phosphorus and ammonia in relation to the corn row. As shown in Table 3, the distance of the application from the row had little or no effect on yields.

Table 2. — Corn Yields After Application of Liquid Phosphoric Acid and Anhydrous Ammonia on Plots in Long-Time Fertility Study

1962 treatments	Long-term treatments (40 years)[a]						
	O	M	ML	MLP	O	RLP	RLPK
	bushels per acre						
1. Check	53.2	68.2	80.7	98.4	62.4	96.7	103.4
2. Phosphoric acid and anhydrous ammonia[b]	82.1	99.6	98.3	102.6	87.3	96.9	103.4
Increase for Treatment 2	28.9	31.4	17.6	4.2	24.9	.2	0

[a] O — no treatment, M — manure, R — crop residues, L — limestone, P — phosphate, K — potash.
[b] Rates of application were 50 pounds of P_2O_5 per acre and 100 pounds of N per acre.

Table 3. — How Placement of Liquid Phosphorus and Nitrogen Fertilizers Affected Corn Yields

Distance of application from corn row[a]	Corn yields, bu.	
	1961	1962
0 inches	81.2	90.1
10 inches	82.7	....
20 inches	80.4	92.3

[a] Rates of application were 50 pounds of P_2O_5 and 100 pounds of N per acre.

Summary

On the basis of two years' studies with wet process liquid phosphoric acid, the following conclusions may be drawn:

- On soils that had tested low in phosphorus, corn and wheat yields were increased about as much by the liquid phosphoric acid as by dry superphosphate (0-45-0).
- The residual or carryover effect of phosphoric acid, as measured by corn yields the year after application, was about like that of superphosphate.
- Liquid phosphoric acid was effective whether applied in band or broadcast treatments.
- Nitrogen and phosphorus needs can be supplied in a once-over rapid operation, using liquid phosphoric acid and anhydrous ammonia.
- Corn yields were not affected by the distance from the row at which liquid phosphoric acid was applied.

PLANS FOR ASSESSING FARMS NEAR URBAN CENTERS

N. G. P. KRAUSZ and FREDERICK G. PINK

SERIOUS tax problems have arisen in Illinois as cities and towns spread into areas that have been traditionally agricultural.

Assessors in Illinois and in most other states are required to assess property at market value. An assessor would err if he valued a farm as residential property before it had actually been subdivided into building lots. But he must consider that a developer would pay more for the farm than another farmer.

As a result, the farmer whose land lies in the path of urbanization often has such a high tax bill that he is forced to abandon operations. It may be some time, however, before the land is put to another use. In the meanwhile it may lie idle under the ownership of a speculator who holds it until he can realize a capital gain.

Measures are needed to alleviate the farmer's hardship and at the same time encourage orderly urban development. Various plans have been adopted in several states.

Preferential tax assessment

One measure in use is the preferential tax assessment plan. Essentially, this plan eliminates certain criteria for assessing property that is on the urban fringe but is used exclusively for agriculture.

In 1959 California and Florida passed laws that combined preferential assessment with restrictive zoning, and two years later Oregon passed a similar law. Under these plans, land which has been used exclusively for farming for a certain number of years is zoned for agriculture and is assessed only on the basis of agricultural use. Preferential assessment is discontinued when the zoning restriction is removed (or, as in California, about to be removed or modified). All factors bearing on true value must then be considered.

New Jersey also adopted a preferential assessment law in 1961. This law stated: "In the assessment of acreage which is actively devoted to agricultural use, such value shall not be deemed to include prospective value for subdivisions or nonagricultural use."

Unlike the laws in California, Florida, and Oregon, the New Jersey statute did not require that the preferred land be zoned exclusively for agriculture. Shortly after the law took effect, the Supreme Court declared it unconstitutional because the state constitution forbids classification of land for assessment purposes. In states that have such constitutional provisions, the zoning feature apparently represents the difference between validity and invalidity.

Deferred tax liability

A second approach to alleviating the farmer's tax burden is the deferred tax liability plan. Land is assessed in two ways — according to its agricultural use and according to its true market value. The resulting difference in tax liability is deferred for future payment.

This plan differs from the preferential assessment plan primarily in that the appropriate governmental unit can recoup the additional taxes when the land is developed or retired from farm use. During the past few years bills sponsoring this measure have been introduced in the Indiana, Massachusetts, and Hawaii legislatures.

Acquisition of development rights

Under a third scheme for stabilizing or reducing the assessed value of fringe-area farmland, a local or state governmental unit can acquire development rights. Should development become desirable in the future, the landowner may repurchase the development rights and then either sell at the optimum price or develop the land himself. Thus, during the interval between selling the rights and buying them back, his tax liability will be related to the profits from the use of the land.

This scheme has a double benefit. By relating assessment to actual rather than possible use, it permits continuation of farming. Moreover, it makes orderly and efficient suburban development possible, thereby eliminating a basic cause of urban sprawl.

California and Maryland have passed legislation authorizing public acquisition of development rights or, as sometimes called, conservation easements.

Administrative practices

The desire to alleviate the farmer's tax burden has occasionally found expression in administrative classification of property. While this practice may work justice in some individual cases, its overall effectiveness is questionable because the lack of general legislative authority is bound to mean uneven treatment. Often the amount of the assessment will depend on the degree of sympathy shown by a given assessor.

Application to Illinois

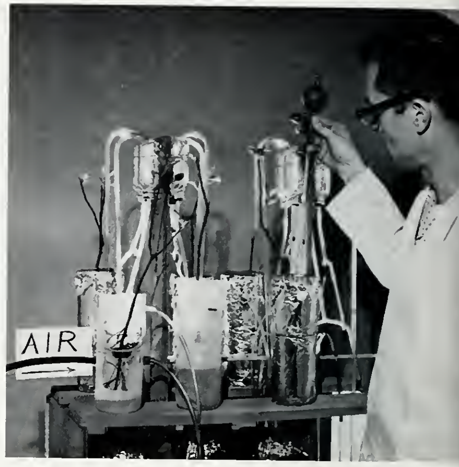
The Illinois constitution requires uniform assessment of real estate. This, however, does not necessarily preclude all legislation stabilizing or reducing valuation for tax purposes. It is possible that the combination preferential tax and exclusive zoning plan adopted by California and Florida can be reconciled with the Illinois constitution. The deferred tax liability scheme likewise does not appear to offend the requirement of uniformity. Nor is there any constitutional prohibition against acquisition of development rights either on a temporary or a permanent basis.

N. G. P. Krausz is Professor of Agricultural Law, Department of Agricultural Economics, and Frederick G. Pink is Research Assistant in Agricultural Law.

APPLE MEASLES

A control may evolve from current studies of manganese and calcium interaction

JOHN FUCIK



John Fucik, Instructor in Pomology, with the equipment which makes it possible to treat upper and lower root systems differently.

Overabundance is not a term normally associated with the nutrient supply of our soils. Yet in some well-developed, acid clay soils the trace element manganese may be present in amounts which are toxic to plants. Evidence of manganese toxicity has been found in several apple orchards in southern Illinois, where soils high in iron and manganese are common.

Symptoms have been most severe on the Delicious varieties. The cortex cells just under the bark are affected first. For reasons not yet known, the affected cells quit functioning normally and eventually die. As large groups of such cells collapse, external signs of the toxicity appear. These show up as pimply, reddish lesions on the bark of the trunk and lower limbs.

The nature of these spots gives rise to the name "apple measles," although the abnormality is more properly called internal bark necrosis. As the disease progresses, these necrotic areas, which extend down to the cambium region, run together. The eventual ring of dead tissue around the trunk will kill the trees if it has not already succumbed to the disease or its secondary effects.

Inconsistencies lead to investigations

It has been conclusively demonstrated that the disease is associated with excessive manganese absorption by the trees and that the situation can usually be corrected by applying limestone to raise the soil pH above 4.5. However, soil and plant analyses have revealed some glaring inconsistencies.

Examples are shown in Table 1, which is based on work done in West Virginia. Note the overlapping in manganese content of diseased and healthy trees and the varied characteristics of the soils on which the problem has occurred.

Consideration of these figures raises questions as to the nature of manganese behavior in the soil and its absorption by the apple tree. For example, what direct effect may the calcium in limestone have on manganese availability and absorption? Does the tree's entire root system, growing within a volume of soil 10 feet deep and 20 feet in diameter, respond uniformly to high amounts of manganese? How rapidly does manganese absorption and movement throughout the tree occur?

Table 1. — Plant and Soil Analyses When Delicious Apple Trees Were Healthy and Diseased[a]

Item measured	Tree condition: Healthy	Tree condition: Diseased
Manganese in plant		
Leaves, p.p.m.	249–1465	718–2068
Bark, p.p.m.	144–535	372–798
Available manganese in soil, p.p.m.	16–305	6–345
pH of soil	4.41–5.83	4.33–4.90

[a] Data from "Internal Bark Necrosis of Apple Resulting From Manganese Toxicity," by Anthony Berg, Genevieve Clulo (Berg), and C. R. Orton. W. Va. Agr. Exp. Sta. Bul. 414T.

To answer these and other questions, we decided first to separate the soil and root systems studies. A water-culture apparatus, shown in the photograph, was devised for studying the root behavior of one-year-old seedlings. With this set-up, we could treat the upper and lower root systems differently and study the effects on the whole tree. While comparable to the field situation where fertilizer and limestone would not be distributed uniformly throughout the rooting zone, this arrangement eliminated or equalized differences in moisture supply, organic matter, aeration, and other soil characteristics which would be expected in the field.

A preliminary experiment answered the question about rate of manganese absorption. Manganese concentration in some plant parts increased 5 to 10 times within 24 hours after the roots had been exposed to high-manganese solutions.

Next, we grew trees for 2 weeks in nutrient solutions containing 200 or 50 parts per million of calcium and 10 or 0.5 parts per million of manganese, in all four possible combinations. The pH was kept constant at 5.5. Each of the four solutions was applied to the top and the bottom

root systems separately. The experiment was run once in 1960 and again in 1961.

At the end of each experiment the trees were cut up and separated into leaves, shoots, stems, upper roots, and lower roots. All these tissues were analyzed for calcium and manganese.

Calcium shown important

Results of these studies indicate that calcium is indeed an important factor in regulating the absorption of manganese through the apple tree's root system. Further, the ability of this process to operate effectively in various root environments is closely associated with the tree's general health and vigor.

Looking at the total fresh weight increase, dry weight of new growth (leaves and shoots), and calcium and manganese content of the roots (Table 2), we can see that the 1960 trees were considerably more vigorous growers than the 1961 group. This no doubt resulted from differences in the length of time that trees were kept in cold storage. All trees were started from seed in 1959, and after a summer's growth were stored at 34° F. Thus the trees in the 1960 experiment were used after one winter's storage, while the 1961 trees were stored an additional year.

Comparing calcium and manganese values of the roots, we note that the upper and lower roots had about the same calcium content in 1960 and again in 1961, but that the lower roots had a higher manganese concentration. This difference was especially marked in the more vigorous 1960 trees.

Table 2. — Growth of Trees in 1960 and 1961 Experiments

Item measured	1960	1961
Fresh weight increase, gm.	4.7	1.7
Dry weight, gm.		
Leaves	.70	.42
Shoots	.12	.11
Pct. calcium		
Upper roots	.67	.43
Lower roots	.69	.40
Manganese, p.p.m.		
Upper roots	349	232
Lower roots	754	276

Now we might ask, what role does calcium actually perform in the process of manganese absorption? Table 3 shows the roots' manganese content as related to the nature of the nutrient solution.

Note that the lowest manganese values are always associated with high calcium and high manganese treatments. The highest manganese values are associated with high calcium and low manganese treatments, except for the upper roots of trees whose lower roots had been treated.

These results would indicate that calcium not only *reduces* excessive manganese intake, but also *increases* manganese intake when external supplies may be low. In other words, calcium seems to actually regulate manganese absorption in some way. Moreover, an important part of this or a related process appears to be that a higher manganese concentration is maintained in the lower roots than in the upper ones. A statistical analysis of these data, however, showed that the tree's overall physical condition affected the calcium regulatory function. In the vigorously growing 1960 group, the interaction of calcium and manganese produced the only significant changes in the manganese differential of upper and lower roots. In 1961 the manganese treatments alone produced significant changes, regardless of the calcium levels in the nutrient solution.

Table 3. — Manganese Contents of Roots After Different Calcium-Manganese Treatments

Treatment	Mn content (p.p.m.) Upper roots	Mn content (p.p.m.) Lower roots
TREATMENT APPLIED TO UPPER ROOTS		
High Ca, High Mn	186	400
High Ca, Low Mn	482	613
Low Ca, High Mn	240	483
Low Ca, Low Mn	253	564
TREATMENT APPLIED TO LOWER ROOTS		
High Ca, High Mn	237	320
High Ca, Low Mn	294	800
Low Ca, High Mn	310	534
Low Ca, Low Mn	320	406

Table 4. — Manganese Contents of Leaves and Stems After Different Calcium-Manganese Treatments

Treatment	Mn content (p.p.m.) Stems	Mn content (p.p.m.) Leaves
TREATMENT APPLIED TO UPPER ROOTS		
High Ca, High Mn	74	159
High Ca, Low Mn	181	272
Low Ca, High Mn	104	204
Low Ca, Low Mn	114	244
TREATMENT APPLIED TO LOWER ROOTS		
High Ca, High Mn	96	176
High Ca, Low Mn	144	242
Low Ca, High Mn	150	220
Low Ca, Low Mn	108	195

That the regulatory function of calcium is not limited to the roots can be seen in Table 4, which shows the manganese concentrations found in leaves and stems. Again the lowest manganese concentrations are associated with the high calcium-high manganese treatments. And (except for stems when treatment was applied to lower roots), highest concentrations are associated with the high calcium-low manganese treatments.

As might be expected from comparing Tables 1 and 4, the manganese concentrations in the leaves and stems of our experimental trees had not yet reached levels high enough to produce typical toxicity symptoms.

Too soon for recommendations

Other experiments now in process were designed to study the movement and availability of soil manganese in relation to calcium and water supply. Results should shed some light on the manganese-calcium environment that the apple tree roots must experience in nature.

The theories developed from laboratory studies of soils and root systems will next have to be tested by growing apple trees in soils treated to create specific manganese-calcium conditions.

Ultimately such studies should lead to practical recommendations for fertilizer and limestone use in Illinois orchards. The results presented here, however, are but the first stepping stones to this final goal.

Groves in Champaign county yield information on

PRAIRIE FORESTS—THEN AND NOW

W. R. BOGGESS

Champaign county, with its acre upon acre of corn and soybeans, seems an unlikely place to find examples of the type of forest that once grew in Illinois. To be sure there isn't much left, but there are about 120 acres, which are owned by the University of Illinois in two separate tracts known as Brownfield and Trelease Woods. These are remnants of the "Big Grove" that once occupied about 10 square miles in a bend of the Salt Fork River, a small stream north and east of Urbana.

Most of the native timber in the prairie region grew along the major watercourses. But a number of groves, like the "Big Grove," were isolated from the main timber stands. The tall trees, growing on firm uplands, must have been a welcome sight to the early settlers, giving them a sense of security. For these people had grown up among trees and were unaccustomed to the vast, unbroken areas of grassland that was so often wet and sloppy underfoot. It is not surprising that the first settlements in the prairie were around these timber stands.

Since the tough prairie sod defied the farming implements of the day, the trees were cleared to make way for the plow and to furnish materials for shelter and fuel. It is ironical, indeed, that more of the original forest than grassland is left today.

Brownfield Woods in 1926

Brownfield Woods was first described in 1926 by C. J. Telford, a forester with the State Natural History Survey. He measured all trees in the woodland that were 3 inches and more in diameter. Sugar maple was the most abundant species, but none had large diameters.

Some ashes, elms, and oaks, however, had reached great size, and Telford spoke eloquently of the "splendid dimensions of occasional trees." Thirty-six trees had diameters ranging from 36 to 66 inches at a point 4½ feet above the ground. One large bur oak had a diameter of 65 inches and a height of 102 feet. Another 45-inch tree was 112 feet tall.

The woodland was heavily used by the public for picnics and family outings. Telford feared that this, along with grazing, would eventually destroy the woods, and he pled for preservation of the area in its natural state. This became a reality in 1939 when the University acquired Brownfield Woods. Since then it has served as an outdoor classroom for teaching and a laboratory for research.

The woods in 1960

In 1960 we remeasured the trees in Brownfield Woods and found many of the big ones still alive. In fact, there are now 20 more trees over 3 feet in diameter than there were in 1926. The following woody species were identified:

Sugar maple (*Acer saccharum* Marsh.), red oak (*Quercus rubra* L.), bur oak (*Q. macrocarpa* Michx.), chinquapin oak (*Q. muehlenbergii* Engelm.), shingle oak (*Q. imbricaria* Michx.), American elm (*Ulmus americana* L.), slippery elm (*U. rubra* Muehl.), white ash (*Fraxinus americana* L.), blue ash (*F. quadrangulata* Michx.), basswood (*Tilia americana* L.), hackberry (*Celtis occidentalis* L.), black walnut (*Juglans nigra* L.), buckeye (*Aesculus glabra* Willd.), honeylocust (*Gleditsia triacanthos* L.), shagbark hickory (*Carya ovata* (Mill.) K. Koch), bitternut hickory (*C. cordiformis* (Wang.) K. Koch), black cherry (*Prunus serotina* Ehrh.), Kentucky coffeetree (*Gymnocladus dioicus* (L.) K. Koch), sycamore (*Platanus occidentalis* L.), hawthorn (*Crataegus mollis* (T&G.) Scheele), hophornbeam (*Ostrya virginiana* (Mill.) K. Koch), pawpaw (*Asimina triloba* (L.) Dunal), redbud (*Cercis canadensis* L.), spice-bush (*Lindera benzoin* (L.) Blume), and bladdernut (*Staphylea trifolia* L.).

Composition of the woods has changed a lot in 35 years. Most of the elms have died as a result of phloem necrosis and Dutch elm disease. Before they started to die, elms made up more than 20 percent of the stand.

The most conspicuous change has been the increase in the number of sugar maples. Not only do they make up more than half the trees above 3 inches in diameter, but there has also been a "population explosion" of maple seedlings and small saplings. This dense understory of young trees has developed as a result of protection from grazing and heavy public use.

Once again the stand is assuming the appearance and characteristics of what foresters call a "normal uneven-aged forest" with trees of many age classes, from the very young to the very old.

Origin of the woods

The origin of the prairie groves, detached as they were and completely surrounded by grassland, has caused considerable speculation. A plausible explanation is that given by H. A. Gleason, an authority on the vegetational history of the Midwest who was formerly at the University of Illinois and was later Head Curator of the New York Botanical Garden.

He suggested that forests were rapidly displacing the prairies until their advance was stopped by prairie fires following the arrival of the American Indian. The fires not only stopped the advance of the forests but caused them to recede on the westward side as they burned from

Trees such as this large oak were once common in the prairie forests of central Illinois.

Elms were also once common, but most of them have died of phloem necrosis and Dutch elm disease.

west to east in the direction of the prevailing winds.

The prairie groves were once a part of these larger bodies of timber but were usually in locations protected by natural fire breaks, such as swamps, streams, or irregular topography. Thus they were preserved, and were isolated as the forest border retreated and the main bodies of timber became smaller. The Indian was followed by the white man, and any further encroachment of the forest onto the prairie was stopped by the rapid development of agriculture.

Just when the forest began invading the prairie is difficult to say. All we know about Brownfield Woods, for example, is that the oldest trees, the bur and chinquapin oaks, are about 400 years old. Were these the primary invaders of the prairie or were they preceded by other generations or other species? It appears that not all parts of the woodland have been occupied by forests for the same length of time, since some of the soils are quite similar to those of the surrounding prairie, while others are well-developed forest soils, suggesting that trees were here before the present stand.

The large number of species in the woodland is characteristic of the kind of forest that occurred in the Wabash river valley. This indicates that forests may have migrated up the major river valleys into the prairie region after the glacier retreated.

What of the future?

We can only speculate on the future composition of the woodland, for who would have predicted the catastrophe that has essentially wiped out the elm population? Barring a similar occurrence, it seems safe to assume that sugar maple will continue to be a dominant species, and perhaps even increase in its degree of dominance. In addition to the present stand of large trees, there are now an estimated 1,200 trees 1 to 2 inches in diameter, and 9,000 seedlings of sugar maple per acre. Then, too, sugar maple can reproduce and grow in shade too dense for many of the other species to survive.

It is fortunate that these woodlands have been preserved for educational purposes. Future students and teachers can use the information we have collected and follow the changes that will occur with natural succession down through the years.

When W. R. Baggess first came to Illinois in 1947, he was in charge of forestry research at the Dixon Springs Experiment Station. He has been on the Urbana campus as Professor of Forestry since 1958.

Survey First Step in Eradicating Hog Cholera

J. A. PORTER, JR., and J. R. PICKARD

Surveys have become part of our American way of life. They provide information on where to build factories and the number of cars or baby buggies to manufacture. They tell the TV networks what programs to continue or discontinue. In Illinois, a survey is being put to still another use. Swine industry leaders in Macoupin county have conducted a survey of their operations and this information is being used to formulate the Illinois hog cholera eradication program.

Hog cholera, a highly fatal disease, is a costly drain on the swine industry of the United States. The disease is estimated to cost the nation's farmers 50 million dollars annually or 45 cents for every pig marketed. In Illinois alone, during September and October, 1962, hog cholera caused the death of 2,000 hogs valued at $40,000.

For years, the swine producer accepted this toll as an unavoidable financial burden. In 1951, however, veterinarians engaged in research work stated that hog cholera could be eradicated from the United States. Canada had conducted successful eradication programs; surely the United States could do likewise. The success of a pilot project in Florida encouraged this belief.

A nine-point eradication program was formulated. Swine producers in the major swine-producing states decided that it was time to launch such a program. Enabling legislation was passed by Congress and 2 million dollars was appropriated to start the program. The next step was the swine industry's.

Committees organized

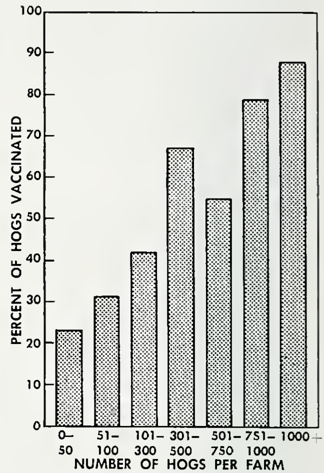
Illinois leaders met in Peoria on June 2, 1961, and organized the Illinois Hog Cholera Eradication Committee. They realized that action had to be initiated at the county level if hog cholera were to be eradicated. They therefore recommended that county committees be formed. A further recommendation was that the county committees conduct farm surveys to determine swine production, movements, vaccinations, and disposal methods. Macoupin county was selected as a pilot county.

The Swine Herd Improvement Association of Macoupin county had already indicated an interest in the eradication of hog cholera. Thirty-one of its members had contributed to the National Hog Farmers' Cholera Fund. On January 30, 1962, the Macoupin County Hog Cholera Eradication Committee was organized. It was composed of swine producers, representatives of the Extension Service and of farm organizations, vocational agriculture instructors, and a veterinarian.

Questionnaire developed

To obtain the data on which to base a program, a survey of local swine operations was planned by the county committee. The following questions were included:

1. Number of hogs raised in 1961_____
   Purebred_____ Commercial_____
2. Number of litters farrowed_____
3. Number of pigs sold as feeders_____
4. Number of feeder pigs purchased_____
   a. Where: Sales barn_____
   Feeder pig dealer_____
   Producer_____
   b. From: Macoupin county_____
   Elsewhere in Illinois_____
   Out of state_____
5. Have you had cholera on your farm in the past 5 years? ( ) Yes ( ) No. If so, when? _____
   Was a veterinarian consulted?
   ( ) Yes ( ) No
6. Hog cholera vaccination program
   a. Did you vaccinate for cholera in 1961? Breeding stock ( )
   Pigs ( ) None ( )
   b. Has cholera vaccination been a regular program on your farm in the past 5 years? ( ) Yes
   ( ) No
   c. Who vaccinates your hogs?
   ( ) Veterinarian ( ) Other
   d. Kind of vaccine used:
   ( ) Double treatment
   ( ) Single treatment
   ( ) Don't know
7. Have you had an outbreak of cholera after vaccination in the last 5 years?
   ( ) Yes ( ) No. Number lost_____
   Cost_____
8. Do you vaccinate for erysipelas?
   ( ) Yes ( ) No. Lepto? ( ) Yes
   ( ) No

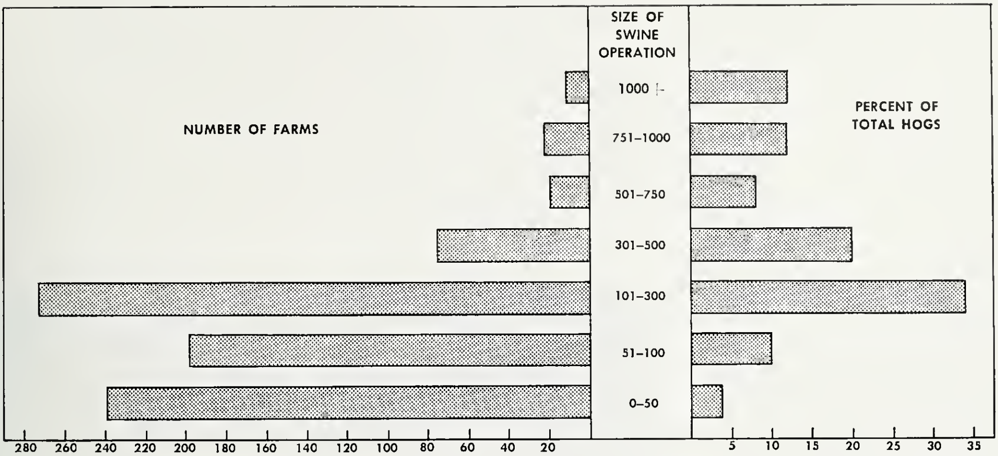


In general, the percentage of hogs vaccinated in Macoupin county in 1962 increased with size of enterprise. (Fig. 1)

Vo-ag boys help

Vocational agriculture classes agreed to conduct the survey in their school districts. The eight vocational agriculture instructors in Macoupin county met with the county committee to arrange the mechanics of the operation. Each instructor was given a supply of questionnaires, a list of swine producers in each township and section, a county map, and other needed materials.

The instructors went over the lists with their classes. Class members were able to add more names to the lists. Each member was assigned a group of producers in the vicinity of



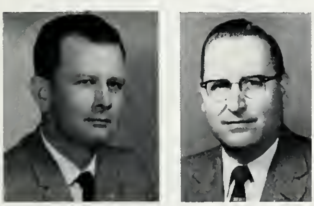
Nearly half the swine in Macoupin county in 1962 were on farms where total number of hogs was 300 or less. (Fig. 2)

his home. Two weeks in April were allotted in which to get the questionnaires answered.

The boys took the work seriously and did an excellent job. They had to do the work in bad weather and sometimes had to travel by tractor to reach a swine operator. They were able to get nearly all the owners to answer the questionnaires.

Essential information

The Macoupin county committee compiled and analyzed the data. Veterinary Medical Extension later publicized the information. Some of the weaknesses of the questionnaire were revealed; however, the data provided the information needed to formulate an effective county hog cholera eradication program.



Both J. A. Porter, Jr. (left), Instructor, and J. R. Pickard, Associate Professor, are in Veterinary Extension.

For example, to devise satisfactory regulations for the movement of livestock, it is important to know the sources of feeder pigs. This information, as brought out by the questionnaires, is given in the table below. This table also shows that about as many farmers bought feeder pigs as sold them, and that about the same number of pigs were involved in each type of transaction.

Another significant item of information was that the small producer was usually less likely to vaccinate his swine than the large producer (Fig. 1). And, as shown in Figure 2, nearly half the swine in the county were on farms producing 300 or fewer hogs.

Maintaining a high level of vaccination was a major point of the nine-point program for hog cholera eradication. The data shown in Figures 1 and 2 emphasized the need for increasing the number of small operators who vaccinate their swine.

Last September the Macoupin county committee presented their findings at a public meeting of the Swine Herd Improvement Association. Next the committee planned to inform the producers in their county about the problem of hog cholera and the necessity for vaccination.

In January of this year the committee began a series of meetings for swine producers in the eight vocational agriculture schools. Interest has been high, and the meetings have attracted producers who did not participate in the survey as well as those who did.

Feeder Pigs Bought and Sold, and Sources of Pigs

Item	Number	Percent
Farmers selling feeders	205	25
Feeder pigs sold	21,934	..
Farmers buying feeders	212	25
Feeder pigs bought	20,353	..
Farmers buying from[a]:		
Salesbarn	....	31
Dealers	....	15
Producers	....	56
Farmers buying in[a]:		
Macoupin County	....	75
Elsewhere in Illinois	....	22
Out of state	....	6

[a] Some farmers purchased pigs from more than one source. Thus the total percentage is over 100.

A basis for other programs

The findings of the Macoupin county survey have been accepted as the foundation for programs in other counties. This survey can be considered an important step in eradicating hog cholera from Illinois.

FATHER IMAGES on the TV screen

Fathers of nursery school children check characteristics of the "ideal" father and use the same criteria to rate fathers portrayed in four family-situation series

JUNE FOSTER

Television has been called the child's "most accessible back door" to the adult world.

Traditionally, the family has been the chief agency through which young children develop their habits, ideas, beliefs, values, and assumptions. Now television, as well as other mass communication media, furnishes a common body of fact and fiction for all children.

That children do learn from TV is indicated by observations of their speech and behavior. Research also shows that a large proportion of this learning is incidental — a youngster picks up certain habits and notions from the example set by his favorite characters. Obviously it is possible for children to form quite an inaccurate and unbalanced picture of the adult world from some television shows.

Much has been said and written about television's defects, real or imagined. Some of the charges are substantiated by content analyses, which indicate that the world of television includes an abnormally high proportion of sexy women, violent acts, and extra-legal solutions to legal problems.

Because the television series portraying family life do not have such glaring shortcomings, they have aroused relatively little concern. Yet parents and every professional concerned with children and family life should be aware of some of the implications of these shows.

Family shows are popular

Family-situation series are favorites among children of all ages, according to previous studies of children's preferences. Research also indicates that television presentations have more impact if they touch on ideas or values for which the child is emotionally ready. One might conjecture that, since children are familiar with family situations, they may attribute more realism to family situation programs than actually exists.

According to other research on what children remember from movies, retention is unusually high when the action occurs in a familiar setting such as home or school. The researchers also concluded that one picture related to a specific social issue might not significantly change a child's attitude, but that exposure to several pictures with the same type of content could have a cumulative effect.

Content of shows studied

A number of questions could be asked about the possible influence of the family-situation series. However, we cannot intelligently discuss the influence of television, until content analyses provide a factual basis for discussion.

The study reported here was concerned with the father image presented in four TV series. Conceivably, if a child watches a number of

shows portraying inadequate fathers, the cumulative effects might make it hard for him to develop a satisfactory concept of the father role. The difficulty could be especially great in fatherless homes or homes with "week-end" fathers. Even when a child's own father is home long enough to provide a model, television is usually there too.

The following assumptions formed a basis for the study: Children must have a male model to develop an adequate concept of the husband-father role; traditionally, a child's own father provides the model; now, television may provide multiple images of inadequate, or at least different, fathers.

Answers were sought to three questions: (1) What is the personality profile of an ideal father? (2) What are the personality profiles of selected television fathers? (3) Are the television fathers like or unlike the ideal father?

Fathers take part in study

Twenty-eight real fathers helped find the answers. They all had children enrolled in the University's Child Development Laboratory nursery school. Fifteen were University faculty members; of the others, seven were professional men, and six were business managers.

The fathers first scored their concept of an ideal father on a specifically designed set of 34 scales. Each scale consisted of a pair of polar adjectives, such as strict-permissive, sociable-solitary, adequate-inadequate, consistent-inconsistent. Seven spaces separated each pair of adjectives, so that a scorer could indicate both the direction and the intensity of his choice between every pair. The middle space was considered a neutral position.

Thirty of the bipolar scales were grouped into nine factors—morality, rationality, uniqueness, excitability, sociability, toughness, evaluative, potency, predictability. The other four scales were individually descriptive of the father image and were considered separately. The mean or average of all the fathers' opinions on these 13 reference points—nine factors and four scales—defined the profile of the ideal father.

Two weeks after the fathers scored their concepts of an ideal father, they used the same scales to score the fathers in four television family-situation series—"Lassie," "Dennis the Menace," "Father of the Bride," and "Danny Thomas." All four programs have a cast of characters including a mother, father, and children of high school age or younger. They were the only programs meeting these criteria which were received in the homes of all the cooperating fathers during the period of the study.

Every father viewed one program in each series during a five-week period, and scored the father role. The image of each television father thus represents a composite judgment based on five programs.

The ideal father

According to the real fathers, the ideal father is very moral, reputable, and wholesome. He is quite rational, objective, and logical. He is more calm and relaxed than excitable and tense; more sociable and extroverted than solitary and introverted.

The scales in the evaluative factor show he is very adequate, valuable, good, competent, effective, and wise. Those in the potency factor describe him as very strong, decisive, and independent, and more dominating than submissive. The ideal father is also consistent and predictable. He is more strict than permissive, and is a warm, secure person.

How the television fathers differed

A large number of statistically significant differences were found between the television fathers and the ideal father. The father in "Lassie" was closer to the ideal than any of the other three. Yet even in this show, the father image differed significantly from the ideal on 8 of the 13 reference points.

The other three fathers differed significantly from the ideal on 10 of the 13 reference points. Certain differences on the bipolar scales were particularly striking. All three fathers were scored as being very significantly *less* adequate, competent, effective, wise, strong, decisive, consistent, and predictable than the ideal.

These three fathers were very much alike. The resemblance was particularly strong between the fathers in "Father of the Bride" and "Dennis the Menace," even though their roles were not equally important in the two series. As any viewer of "Danny Thomas" would expect, he was rated more excitable, unique, and sociable than the others, as well as less predictable and rational.

Again it would come as no surprise that Mr. Mitchell in "Dennis the Menace" was the only really permissive father. All the television fathers, however, were scored as being significantly less strict than the ideal father.

According to these results, television does present multiple images of fathers that not only resemble one another but differ from the ideal father described by a group of real fathers.

Future studies desirable

The social anxiety caused by the unknown effect of television warrants not only additional content analyses of the way in which social roles are portrayed in family television series, but also exploratory studies into the amount of realism children perceive in the roles portrayed in family television series.

An awareness in parents of television as a powerful socializing force in the lives of children will hopefully stimulate them to evaluate, interpret, and censor, if necessary, the images of family life and social roles presented in family television programs.

Formerly on the University staff, June Foster is now Day Care Licensing Representative, State Department of Mental Health. This article is based on a thesis that Mrs. Foster wrote for her M.S. degree in Home Economics.

Volunteer leaders tell the accomplishments of agriculture to Chicagoland groups

CARL F. MEES, author of this article, is Extension Coordinator for Cook county, having formerly been Farm Adviser there. He brings together all segments of the Cooperative Extension Service that are operating in the county.

THE SUCCESS STORY of agriculture is being told in the Chicagoland area. During the 12-month period ending January 31, 1963, more than 5,500 people in 105 organized groups have learned how well they and their families have fared in having plenty of wholesome food to eat. They have learned, too, that the major impetus behind this abundant food story has been the research and teaching of the Land Grant universities throughout the nation. In addition to the people who have heard the story, thousands of others have read about it in the press.

Planning the program

All this grew out of a committee meeting on September 21, 1961. Present were the five volunteer leaders composing the Cook County Extension Service's public affairs committee, the county Extension staff, and members of the Agricultural Economics Department, University of Illinois.

The committee believed that most people in the Chicago area really did not understand agriculture and its important role in the economy of the nation. To acquaint people with the scope of agriculture was a tremendous task that would require careful planning. After much study the committee decided that the first step would be to develop a 30-minute program that would tell the success story of agriculture. Audiences in the beginning could well be the 211 Rotary, Kiwanis, and Lions Clubs in the area, as well as other organized civic and church groups.

Specific evaluation techniques are difficult to establish for a program of this type. Therefore, for the first year of operation, the committee established the simple objective of 50 presentations with a minimum of 1500 in attendance.

Asked to assist in this project were 28 volunteer leaders who were well acquainted with agriculture's problems and had considerable experience in making public appearances. So that they would all present the same basic material, each received a handbook, "Food and Agriculture," by Robert Spitze and Harold Guither of the University staff. A set of slides was prepared for a visual presentation, together with a "handout" circular which summarized the presentation.

A trial run of the presentation was made on January 23, 1962, for the 28 volunteer leaders and other key agricultural leaders in the county. The volunteer leaders agreed that the story was well told and that the time had come to offer the program to the public.

A brochure describing the program and listing the speakers was sent to Rotary, Kiwanis, and Lions Clubs in the county. Other groups were also told about the program.

A variety of audiences

The first presentation was given before the St. John's Men's Club on March 2. Speaker was Harold Bergman, dairy farmer in Palatine township.

The second request came from the Gold Coast Lions Club in Chicago for March 14, and George Menard from WBBM-TV was the speaker. Paul Johnson, Editor of *Prairie Farmer,* made the third presentation, which was before the Arlington Heights Lions Club on March 20.

Soon requests were rolling in. The volunteer speakers responded to the challenge, and before the year was over, almost the entire roster of speakers had given one or more presentations. All seemed to enjoy cooperating in the venture.

More than 80 of the presentations have been before Rotary, Kiwanis, and Lions Clubs. The program has been most popular with Kiwanis Clubs, especially during Farm-City Week in November, when 25 clubs requested the program.

Church groups, garden clubs, and farm groups have also requested the program. One of the most interesting groups was a ladies' organization, "The Bohemian Women's Club," that met in Chicago's Loop.

Response to the program

If the number of questions asked is an indication of interest, our speakers say the program was a success. These are some of the things people wanted to know:

Is the family farm disappearing?

With the present expansion in population, is there danger that sometime in the future we may be faced with a food shortage?

Why should agricultural prices be supported?

Is our past experience being used to the best advantage in solving our present agriculture problem?

Occasionally somebody asked why we should pay farmers not to produce a commodity of which we already have a surplus and which we do not need.

After the presentations, club officers often sent us letters which contained comments such as these:

"Many of our members have mentioned how much they enjoyed the interesting, informative presentation.

OBJECTIVES FOR THE COLLEGE AND ITS STUDENTS

K. E. GARDNER

INSTITUTIONS, like people, must have aims and objectives to be most effective. In the University catalog for 1890-91, we find a statement about the aims of agricultural education that is as valid today as it was 70 years ago:

"The aim of this college is to educate scientific agriculturists and horticulturists. The frequency with which this aim is misunderstood, demands that it shall be fully explained. Many who look upon agriculture as consisting merely in the manual work of plowing, planting, cultivating, and harvesting, and in the care of stock, justly ridicule the idea of teaching these arts in a college. The practical farmer who has spent his life in farm labors, laughs at the notion of sending his son to learn these from a set of scientific professors. But all this implies a gross misunderstanding of the real object of agricultural science. It is not simply to teach *how* to plow, but the reason for plowing at all — to teach the composition and nature of soils, the philosophy of plowing, of manures, and the adaptation of the different soils to different crops and cultures. It is not simply to teach *how* to feed, but to show the composition, action, and value of the several kinds of food and the laws of feeding, fattening, and healthful growth. In short, it is the aim of the true agricultural college to enable the student to understand thoroughly all that man can know about soils and seeds, plants and animals, and the influences of light, heat, and moisture on his fields, his crops, and his stock, so that he may both understand the reason of the processes he uses, and intelligently work for the improvement of those processes. Not 'book farming,' but a knowledge of the real nature of all true farming, of the great natural laws of the farm and its phenomena — this is the true aim of agricultural education. Agriculture involves a larger number of sciences than any other human employment, and becomes a fit sequence to any collegiate training.

"The steady aim of the trustees has been to give the College of Agriculture the largest development practicable, and to meet the full demand for agricultural education, as fast as it shall arise. Agricultural students are especially invited to the University.

"Boards of agriculture and agricultural and horticultural associations are invited to cooperate with the University in its efforts to awaken a more general appreciation of the value of education, and to aid those who desire to avail themselves of its facilities for instruction."

Before a college such as ours can achieve its own aims, it should guide students in developing worthwhile personal objectives. The following list, which I have entitled, "What Do We Want From College Graduates?" has been distributed to all freshmen entering any of the curricula in the field of agriculture:

1. A willingness to keep on learning — a craving to read, to study, to observe.

2. A thorough concept of the ethics of work. The desire to sweat at a job.

3. The ability to write effectively and to speak with clarity and conviction.

4. Technological competence in an area of work.

5. An understanding of the scientific process of obtaining facts.

6. Common sense and the ability to use good judgment.

7. A comprehension of the business world and our competitive economy which has made us world leaders in business and industry, including agriculture.

8. The desire for achievement and advancement — personal "drive."

9. The ability to cooperate and work on a team.

10. Loyalty to the organization and its objectives.

11. An abiding desire to serve in one or more ways. For example: (a) pushing forward the frontiers of knowledge; (b) providing a better or more economical product; (c) helping people to help themselves.

12. The ability and desire to accept responsibility.

13. That incomparable attribute of enthusiasm for the job or the project.

14. A deep conviction of the importance of the moral code — honesty, fairness, decency.

Of course the above "check list" is idealist, but what is wrong with idealism? Prime Minister Benjamin Disraeli said, "Aim high. You will never rise any higher than your thoughts."

K. E. Gardner is Associate Dean of the College of Agriculture and Professor of Nutrition in the Department of Dairy Science.

It was one of the best meetings we have ever had."

"We found the talk, 'Food in Our Society,' very interesting. At first we were not sure it would be of sufficient interest to our urban group to warrant scheduling. We are happy now we did. Thanks for securing a speaker."

Follow-up presentations

Some service clubs that heard the presentation have requested another one. Follow-up presentations are now being planned. They will supplement the present program, not replace it.

The committee is assured that the speakers, having just come through a pleasant and successful experience, will be happy to continue extending the teachings of the College of Agriculture. This is in line with the tradition of the Cooperative Extension Service, which, since its origin, has had the help of volunteer leaders in reaching the people.

RESEARCH IN BRIEF

Factors Affecting Lamb Gains and Vitamin A Status

A multi-factored experiment has been conducted in the Animal Science Department to clarify reports about the way nitrate and various other compounds affect average daily gain and liver storage of vitamin A in growing fattening lambs.

The compounds and treatment levels were as follows: vitamin A (0 and 14,000 international units per day); alpha-tocopherol (0 and 100 milligrams per day); potassium nitrate (0 and 4 percent of air-dry feed); thyroid treatment (tapazole, 150 milligrams per day; control; and triiodo-l-thyronine, 100 micrograms per day). Vitamin A, alpha-tocopherol, tapazole, and triiodo-l-thyronine were injected weekly.

All possible combinations of treatments were studied. One hundred forty-four western crossbred lambs averaging 67 pounds in weight were randomly allotted to the different treatments. The lambs were self-fed a complete pelleted ration. After 60 days they were slaughtered and liver samples were analyzed for vitamin A.

Average gain for all lambs during the experiment was 0.53 pound per day. Rate of gain was not affected by vitamin A or alpha-tocopherol; nor was it affected by potassium nitrate in the absence of thyroid treatment.

Tapazole, a thyroid inhibitor, decreased rate of gain significantly (average daily gain, 0.50 pound per day). Triiodo-l-thyronine, the active principle of the thyroid gland, increased rate of gain significantly (average daily gain, 0.56 pound per day). Potassium nitrate augmented the effects of both compounds. Average daily gain for potassium nitrate and tapazole together was 0.47 pound; for potassium nitrate and triiodo-l-thyronine, 0.59 pound.

Adding vitamin A significantly increased the amount stored in the liver. In the control animals, vitamin A content was 37.8 micrograms per gram of fresh liver, while in those receiving additions of vitamin A, it was 54.5 micrograms. None of the other treatments had any apparent effect on vitamin A status. — *T. R. Cline, E. E. Hatfield, and U. S Garrigus*

Aids in Diagnosing Vitamin A Deficiency in Beef Cattle

Veterinarians have often expressed a need for aid in field diagnosis of vitamin A deficiency in beef cattle. Recent work in the College of Veterinary Medicine has shown that two procedures for determining vitamin A status may be used by practicing veterinarians.

One procedure, the conjunctival smear, is based on the important role of vitamin A in maintaining the integrity of the epithelium, or covering of the skin and mucous membranes. It is known that a deficiency of vitamin A causes epithelial tissues to become cornified (horny) and enlarged. Thus, an indication of vitamin A status is provided by a count of cornified cells in a smear of the conjunctiva, the membrane that lines the eyelids and covers the front of the eyeball. Animals with subnormal amounts of vitamin A in the liver had more than three times as many cornified cells as did animals with enough vitamin A.

A second procedure involves ophthalmoscopic examination of the retina. It depends upon the concentration of rhodopsin (a pigment of the retinal rods) as an index of the general systemic level of vitamin A. Results of ophthalmoscopic observations on fattening steers accorded with those previously reported for dairy calves.

With a decrease in the systemic level of vitamin A, the level of the retinal cycle falls and the concentration of rhodopsin in the rod cells decreases. As a result, the tapetum lucidum (the iridescent pigment epithelium that causes an animal's eyes to shine in the dark) lightens in color and appears "bleached out." Animals with less than 10 micrograms of vitamin A per gram of fresh liver had a grayish-white to light blue color pattern. In normal animals, the pattern is green to orange.

Both procedures described here can be used to estimate the vitamin A status of beef cattle before gross signs of deficiency appear. Early detection of vitamin A deficiency allows early, and therefore more effective, treatment. — *W. G. Huber*

Impact of Three Hog-Price Support Programs on the Hog Sector of the Economy

The primary purpose of a current study in the Department of Agricultural Economics is to measure and appraise the impact of alternative hog-price support programs on the hog sector of the economy.

Supply and demand elasticities have been calculated on the basis of hog supply at the farm and demand at the central market. Three different formulas were used. Supply elasticity (the percentage increase in production that results from each 1-percent increase in price) was 0.0670, 0.2174, and 0.0608, according to the different formulas. Demand elasticity (the percentage decrease in consumption that accompanies a 1-percent increase in price) was calculated at −0.0981, −0.8655, and −0.1299.

These elasticities are being used in an analysis of three alternative price support programs. The three programs, as described by Marc Nerlove of Stanford University, are:

I. "Pure support." The government determines a support price above the equilibrium price, and buys and destroys all the excess sup-

ply. This is somewhat like the support programs which have operated since the end of the second World War.

II. "Subsidy type." A support price in excess of the equilibrium is set. Farmers are allowed to sell all they produce for whatever it will bring, but the government makes up the difference between the market price and the support price in the form of a subsidy per hundredweight.

III. "Production control." Direct controls restrict output to the level which brings about the desired prices.

Our analysis of these programs has been on the basis of the welfare losses they would cause. We have defined welfare losses as the government expenditures minus the net increment to consumers' and producers' surpluses.

With this definition, welfare losses will always be greatest under Program I. Whichever of the other two programs will involve the greater welfare loss will depend on the level of price support and on the elasticities of supply and demand. Under both programs, losses increase as the level of price support is raised.

Higher welfare losses can result from higher elasticities of both supply and demand under Programs I and III. But under Program II losses decline as elasticities increase.

When supply elasticities are assumed to be zero, no welfare losses are involved under Program II. However, some differences do exist between Programs I and III. Producers' surplus is going to increase more under both Programs I and II than under III when supply elasticities are zero, so we can conclude that, under these circumstances, I is preferable to III.

If supply elasticities are greater than zero, and programs are ranked by welfare loss per dollar of net increment to producers' surplus (welfare loss ÷ producers' surplus in dollars terms), III is always preferable to I and II. — *V. I. West and W. C. Ko*

New equipment in a 16-foot trailer provides a versatile mobile laboratory for study of light reflectance.

Mobile Laboratory Is Unique Research Tool

Light reflectance research in the Forestry Department shifted into high gear in 1962 when new equipment was built into a 16-foot-long trailer. The result was a unique mobile laboratory with wide scope and versatility.

Key feature of the laboratory is a new spectrophotometer with digitized readout. The spectrophotometer operates in the ultra-violet, visible, and near-infrared spectra, and the digitized readout transfers reflectance data directly to IBM cards during data collection. The digitized readout accelerates data collection and handling, and reduces data-processing by 60 percent.

The mobile laboratory was equipped and instrumented with the financial support of the Office of Naval Research, U. S. Navy. It is part of a long-range light reflectance research program begun with ONR support in 1959 (ILLINOIS RESEARCH, Spring, 1961).

Laboratory mobility permits data collection in areas remote from the campus. During 1962 field activities ranged from southwestern Wisconsin to the Dixon Springs Experiment Station in Pope County, Illinois.

Capabilities of the laboratory have led to several requests that current research be expanded to serve such diverse fields as archeology, engineering, geology, public health, and satellite reconnaissance. — *C. E. Olson*

COMING EVENTS

(A partial list of meetings scheduled at Urbana)

April 19-25: Leisurecraft and Counseling Camp (4-H Memorial Camp)

May 4: F.F.A. Awards Day Program

June 12-14: Illinois Homemakers Extension Citizenship and Organization Conference

June 18-21: State 4-H Club Week

June 18: Illinois Crop Improvement Association Annual Meeting

June 19: Illinois Crop Improvement Association and Illinois Seed Dealers Association Tour of Agronomy South Farm

June 20: Agronomy Day

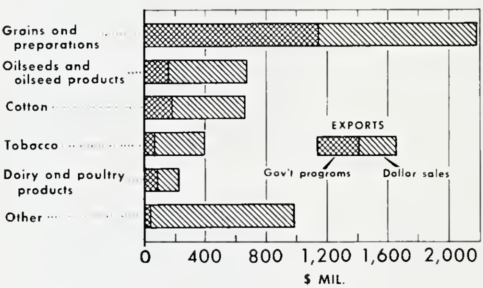
FARM BUSINESS TRENDS

MANY IMPORTANT facts about the export of U. S. farm products are brought out in the charts on this page, all of which are from the U. S. Department of Agriculture.

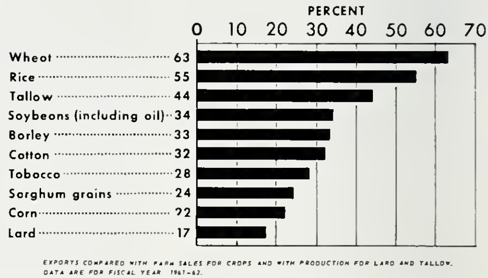
As shown in Figure 1, nearly $2,200 million worth of grain and preparations (mostly wheat, flour, and feed grains) were exported in the fiscal year 1961-62. About half of these products were shipped under foreign aid programs. The value of oilseeds and oilseed products (principally soybeans) was nearly $700 million.

In Figure 2, exports of various products are shown as percentages of the total production. Note that 63 percent of the wheat crop, 34 percent of the soybeans, and 22 percent of the corn marketed was shipped to foreign markets.

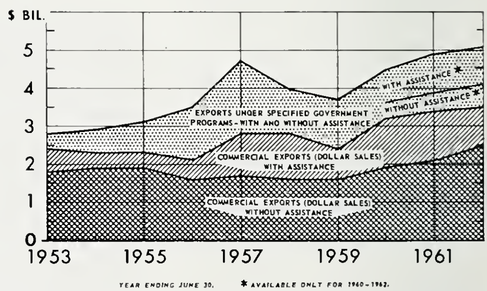
Figure 3 breaks down our exports into those sold for dollars without government assistance (bottom section); those sold for dollars but at prices below those in this country (middle section); and exports for foreign aid (upper section). Commercial exports without government programs increased from $1.6 billion in fiscal 1959 to $2.5 billion last year. — *L. H. Simerl, Professor of Agricultural Economics*



Value of farm products exported in 1961-62. Grains and grain products accounted for most of the exports under government programs. (Fig. 1)



Percentages of various products exported. Foreign markets provide big outlet for many U. S. farm products. (Fig. 2)



Value of products sold for dollars without government assistance, sold with assistance, and exported under government programs. In 1961-62 dollar sales accounted for 69 percent of total farm exports. (Fig. 3)

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Summer, 1963

ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

IN THIS ISSUE

Petunia *Coral Satin* is one of many varieties that visitors may see at the Trial Garden of Annuals and Bedding Plants (page 10).

Volume 5, Number 3 UNIVERSITY OF ILLINOIS COLLEGE OF AGRICULTURE URBANA, ILLINOIS

ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

CONTENTS

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M. B. Russell..............Associate Director

Adrian Janes.................Station Editor

Margery E. Suhre....Editor, ILLINOIS RESEARCH

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DEANS OF THE COLLEGE OF AGRICULTURE: HERBERT W. MUMFORD

When Herbert W. Mumford became third Dean of the College of Agriculture, the College was firmly established as a part of the University, and was strongly supported by the people of Illinois. A lesser man would have been satisfied with maintaining the status quo. But Mumford, as one of his colleagues said of him, saw "a little farther and a little more clearly" than most people.

Mumford's application of economic theory to agricultural problems is perhaps his greatest contribution to agriculture. When he became Dean in 1922, farmers were already suffering from a mild form of the economic malaise that was to infect the entire nation seven years later. Mumford saw clearly that the marketing of agricultural products would play as important a role in the years ahead as methods of increasing production had played in the past. In 1928, he launched a series of agricultural adjustment conferences in each farming-type area of the state. These conferences were continued annually until the federal adjustment program was begun in 1932.

Since the beginning of his career, Mumford had been interested in the economic aspects of agriculture, and his bulletin, "Market Classes and Grades of Cattle" (1902), was the first bulletin published in the United States about marketing an agricultural product. The present system of selling livestock on the terminal markets according to classes and grades is largely the result of Mumford's pioneer work in this field.

Mumford was born in Moscow, Michigan, in 1871, and was graduated from Michigan Agricultural College (now Michigan State University) in 1891. After four years on the home farm, he joined the staff of his alma mater, becoming professor of animal husbandry in 1899. In 1901, he came to Illinois as professor and chief of animal husbandry, and was appointed Dean of the College of Agriculture upon the retirement of Eugene Davenport in 1922.

Dean Mumford died May 31, 1938, as the result of an automobile accident. Among the many tributes paid to him after his death was this one by Henry A. Wallace, then Secretary of Agriculture: "He was one of the outstanding, forward-looking men in American agriculture, and his untimely passing is a great loss not only to the state of Illinois but also to the nation." — *Richard G. Moores*

Trained pigs did not have to receive a tranquilizer or anaesthetic before electrocardiograph was attached. At right Dr. B. C. Johnson, who initiated the experiments, studies an electrocardiogram. With him is Dr. G. S. Smith, who also worked on the project.

STRESSES OF STARVATION AND REFEEDING

Knowledge gained from experiments with swine will be applied to the problem of refeeding people who have undergone prolonged periods of starvation

JACK L. SMITH

When survivors of plane crashes, shipwrecks, and other disasters have gone without food for many days, it hasn't been easy for them to return to normal eating habits. After the first few meals, they become nauseated, their respiration and heart rates go up, and their blood pressure increases drastically. All these signs of stress, except the high blood pressure, disappear within a few days. Blood pressure doesn't drop back to normal for many months, if ever.

Dietary components studied

This stress might be controlled if we knew whether any particular part of the diet were causing the trouble. The Division of Animal Nutrition has been investigating the problem in cooperation with the Air Force. We are trying to determine which, if any, of the major dietary components (fat, carbohydrate, and protein) causes the immediate stress, and we have also been studying the long-term effects of starvation and refeeding.

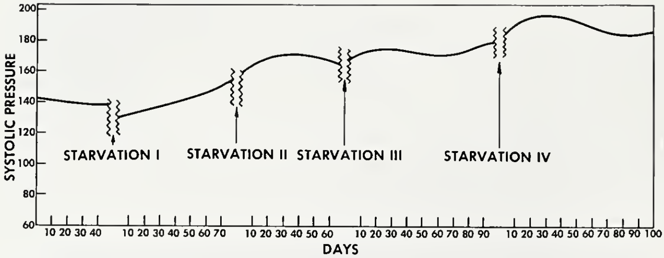
In particular, we have examined the respiration rate, heart rate, blood pressure, and electrocardiographic patterns of swine during various stages of starvation and during refeeding with single dietary components.

Why swine were used

We chose the pig as the experimental animal for several reasons. First, the pig is more like man in physiology (general body functions) and cellular structure of the blood vessels than are the common laboratory animals such as the mouse, white rat, rabbit, or guinea pig. Like the human, the pig develops diseases of the heart and blood vessels spontaneously, and is becoming more and more used as an experimental animal in cardiovascular experimentation.

The pig is like man, too, in eating

Jack L. Smith, postdoctoral trainee in Animal Science, assumed day-to-day responsibilities for the experiments in January, 1962, after animals had undergone the fourth starvation period.



Average systolic blood pressure of four swine that had been subjected to four episodes of starvation and refeeding.

nearly anything and any amount placed in front of him. Most common laboratory animals won't do this. Finally, the pig is relatively high on the intelligence scale of animals — higher than the dog, for example — and is easily trained.

Measurements taken

Four pigs were used in the experiment. The first step was to train them so that we could routinely obtain electrocardiographic recordings and determine blood pressure and heart and respiration rates without using anaesthetics or tranquilizers.

To take the blood pressure, for example, we trained the animals to lie down on their right side so we could place a blood pressure cuff on the left fore-leg. The pressure was determined by using a stethoscope and pressure gauge like those used by the family physician. (In current experiments, the stethoscope has been replaced by a sensitive microphone and the pressure gauge by a recording manometer.) Heart rate was determined with the stethoscope, and respiration by observation.

Starving and refeeding

After the necessary training and standardization period the pigs were fasted for 30 to 50 days or until they had lost about 25 percent of their body weight. Throughout the starvation period they had free access to water. They showed little reaction to the starvation period and after the first few days slept most of the time. Their general metabolism decreased, as well as their heart rate, respiration rate, and blood pressure.

Because of the pig's willingness to eat anything put in front of it, we could study the effects of feeding each animal a single dietary component for the first several days after starvation. One pig was fed only corn oil; a second pig, milk protein; a third, carbohydrate as glucose; and a fourth, carbohydrate as starch ("bound glucose"). After about a week on the single dietary components, the pigs were fed to normal weight (375 pounds) on a complete ration.

Starvation and refeeding periods were then repeated, with each pig receiving a different dietary component, until all four pigs had received all four dietary components.

Immediate signs of stress

The carbohydrate glucose caused the severest stress. Signs of stress appeared within an hour after the first meal was ingested. If the carbohydrate was fed in the form of starch, the stress would be delayed for 5 to 6 hours.

The pigs would consume 5 to 6 pounds of the carbohydrate for the first meal, and 2 to 3 pounds for each subsequent meal. Even though each meal caused the animal great stress, it would continue eating. By contrast, when a similar experiment was attempted with a white rat, it would eat only one large meal and then would eat only a very small quantity at a time.

Refeeding with corn oil caused less immediate stress on the animal than refeeding with either form of carbohydrate, and protein caused the least stress of all.

Immediate stress was also affected by the size of the meal and the rate at which the first meal was consumed. The larger the meal and the faster it was eaten, the greater was the immediate stress.

Long-term effects

One of the most interesting observations in this study has been the long-term effects on blood pressure. Chart at left shows average systolic blood pressure for the four animals while they were being fed a complete ration at the beginning of the experiment and after each starvation period. Average blood pressure was 130 mmHg at the beginning of the experiment and increased after each starvation episode until it reached 190 mmHg at the end of the fourth starvation. Blood pressure remained at this level for 9 months.

Other pigs of the same age as the experimental pigs were observed for 6 to 9 months and had average blood pressures of about 145 mmHg. In man, systolic blood pressures over 160 mmHg are generally considered to be in the hypertensive range.

Present studies

A similar experiment is now in progress with 16 swine to further study the long-term effects of starvation and refeeding. The same kind of observation will be made on each animal as outlined above. Single dietary components will not be fed; instead, each animal will be fed a complete ration except during the starvation episodes. One group of three pigs will be exercised twice weekly on a treadmill until they are near exhaustion to determine if additional stress will have any effect on blood pressure.

Another group will be fed a diet which is low in carbohydrate and in which 50 percent of the calories are derived from fat.

It is hoped in the present experiments to study the underlying cause of the immediate stress as well as the reason for the long-term effects.

With a controlled atmosphere and a mold retardant,

THE DRYING TIME OF CORN CAN BE EXTENDED

E. F. OLVER, G. C. SHOVE, and D. R. MASSIE

If corn could be dried over a period of several months, the job could be done with relatively small blowers and heat sources. The main problem would be to keep mold from forming. A method of solving this problem is now being explored in the Department of Agricultural Engineering.

Equipment used in the study included a drying chamber which held about 14½ bushels of high-moisture corn; a heat pump run by a ¼-horsepower motor; and a positive-displacement rotary blower which measured air flow (Figs. 1 and 2). Temperature was measured in the drying chamber through the use of thermocouples. A 25-point stepping switch connected the thermocouples to a single-point recorder that recorded the temperatures (Fig. 2).

A closed-circuit recirculating air cycle was used in the drying operation (Fig. 1). The dry air entered the top of the drying chamber and passed down through the corn, collecting moisture. The corn was dried adiabatically — that is, the air did not gain or lose total heat.

The moist air was then removed from the bottom of the drying chamber and passed over the cold evaporator coil, where much of the moisture was lost through condensation. After leaving the evaporator at the dew-point temperature, the air was heated by being passed over the condenser coil. The blower then moved the air through the orifice meter into the top of the drying chamber to repeat the cycle.

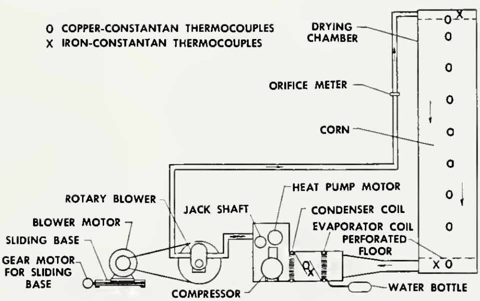
Five tests were conducted. Treatment of the corn, initial and final moisture contents, length of tests, and the time at which mold appeared are given in the table. In the first four tests mold appeared before the grain was completely dried. But in test five, where the corn was treated with 0.8-percent sodium metabisulfite, mold growth was effectively retarded.

According to these tests, corn can be successfully dried over an extended period with a small heat pump unit. It is necessary, however, to use an enclosed atmosphere and an adequate mold retardant.

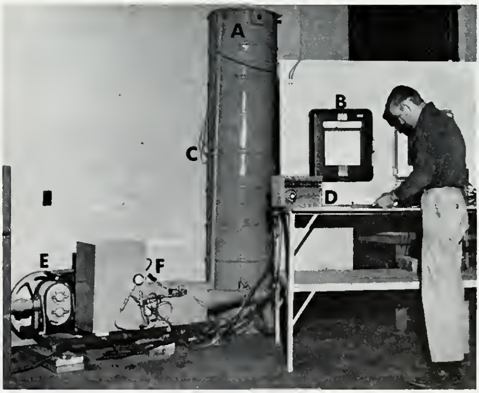
Summary of Corn-Drying Tests

Test number and treatment	Air flow	Moisture content Initial	Moisture content Final	Mold appearance	Length of tests	Aver. drying air temp.
	ft./min.	pct.	pct.	days	days	°F.
1 None	10.7	34.0	9.5	8	12	94.6
2 None	10.7	22.0	9.5	5	9	89.6
3 CO_2	10.7	26.5	9.5	5	5	88.2
4 Sodium metabisulfite, 0.4%	10.7	34.0	9.5	13	23	86.3
5 Sodium metabisulfite, 0.8%	10.7	23.0	10.5	..	12	85.2

E. F. Olver and G. C. Shove are both Associate Professor of Agricultural Engineering, and D. R. Massie was formerly Assistant in Agricultural Engineering.



Heat pump drying unit. (Fig. 1)



Overall view of testing equipment. A — drying chamber; B — copper-constantan recorder; C — orifice meter; D — switching unit; E — blower; F — heat pump unit. (Fig. 2)

CHANGES IN MILK PRICES affect consumption more than has been believed

R. W. BARTLETT

How much does a change in retail milk prices affect milk consumption? The answer to this question is important to private firms, farmers' cooperatives, and the government in formulating dairy marketing policy.

Short-run studies

Early studies based upon short-run periods and small price changes have indicated a highly inelastic demand for milk. That is, people apparently changed their milk consumption little, if at all, in response to small changes in retail milk prices.

Results of some of these studies are summarized in Table 1. In 13 of the 16 studies based upon small price changes, the demand for milk was highly inelastic, or less than —.40. In other words, consumers reduced their milk purchases by less than 4 percent for each 10-percent increase in price.

Different results were obtained, however, when price changes were large (Table 1). A short-run study in Syracuse indicated that demand is not highly inelastic when price changes are large, and another study in Washington indicated that demand may even be elastic. On the Washington market in 1940, per capita milk consumption increased by 9 to 14 percent for every 10-percent reduction in price.

Long-term studies

Long-term studies have also indicated that demand for milk is not always highly inelastic. If enough time is allowed for a response to take place, milk consumption may be substantially affected by milk prices (Tables 2, 3, and 4).

Early long-term studies of price elasticities include the ones summarized in Table 2. Each study indicated that milk consumption would tend to increase with a decrease in price. The simple average of the coefficients of price elasticity for the 10 studies was —.51. That is, for each 10-percent change in retail price, per capita milk consumption would change 5.1 percent.

Study of 55 markets

Three important factors affecting per capita milk consumption are consumer income, retail price, and proportion of nonwhites. In a recent study, 55 markets were divided into five groups or quintiles on the basis of average per capita milk consumption. The first quintile included the 11 markets with the highest per capita consumption; the second quintile, the 11 markets with the next

Table 1. — Short-Run Price Elasticity Coefficients Derived From Previous Studies of Individual Fluid Milk Markets

Market and investigator[a]	Period	Price elasticity coefficients[b]	Basis for coefficient
SMALL PRICE CHANGES			
Grand Rapids (Gaumnitz and Reed).....	Aug. 1934-Mar. 1935	(0)	1 price change
Boston (Cassels)	1922-1931	(—.06)[c]	Average for 34 price changes
Twin Cities, Minn. (Gaumnitz and Reed)..	1924-1932	(—.09)	28 price changes treated as 10; 4 direct responses; coefficients, —.45 to +.26
Chicago (Ross)	1920-1922	(—.1)[c]	8 price changes
N. Y. metropolitan area (Ross)..........	1919-1924	(—.1)[c]	About 25 price changes
N. Y. metropolitan area (Blanford)......	1933-1937	(—.1)	Average for 10 price changes
Connecticut (Cassels)	1922-1931	(—.14)[c]	Average for 12 price changes
Boston (Gaumnitz and Reed)...........	Apr. 1934-Apr. 1935	(—.15)	2 price changes
Baltimore (Gaumnitz and Reed).........	1926-1931	(—.21)	2 periods of price change
Baltimore (Cassels)	1922-1931	(—.26)[c]	Average for 6 price changes
Detroit (Gaumnitz and Reed)...........	Apr. 1934-Mar. 1935	(—.29)	2 price changes
Boston (Gaumnitz and Reed)...........	1922-1931	(—.31)	40 price changes treated as 15; 4 direct responses; coefficients, —1.35 to +.56
Kalamazoo (Gaumnitz and Reed)........	July 1934-Mar. 1935	(—.34)	2 price changes
Portland, Me. (Luke).................	1948	—.45	1 price change
East Conn. community (Brinegar)........	1948-1949	—.48	Average for 3 price changes
Evansville (Gaumnitz and Reed).........	May 1934-Mar. 1935	(—.87)	1 price change
LARGE PRICE CHANGES			
Syracuse, N. Y. (Jeffrey and Feldman)....	1957-1958	—.7	Average for first 6 months after 13-percent price increase
Washington, D.C. (Stiebeling, et al.).....	1940	(—.9 to —1.14)[d]	Government subsidy program, 60-percent price decrease

[a] References to the studies are included in University of Illinois Agricultural Economics Bulletin 7, which may be obtained by writing to the Department of Agricultural Economics.
[b] Coefficients in parentheses calculated by Bartlett unless attributed otherwise.
[c] Coefficients as stated by Rojko.
[d] Calculated by Wilson.

Table 2. — Long-Run Price Elasticity Coefficients for Specific Markets From Previous Studies

Market[a]	Period	Price elasticity coeffi-cients[b]
Birmingham	1936–1949	−.31
Chicago	1940–1952	−.60
New York	1931–1939	−.54
New York	1940–1949	−.30
New York	1950–1959	−.42
Northern New Jersey	1940–1949	−.83
Northern New Jersey	1950–1959	−.39
Ohio (9 markets)	1953–1955	−.54
St. Louis	1949–1957	−.38
Springfield, Mass.	1950–1956	−.75
Ten-study aver.	....	−.51

[a] Sources: Birmingham study — Ala. Agr. Exp. Sta. Bul. 282, 1952; Chicago — *Illinois Farm Economics*, June 1953; New York and New Jersey — Cornell Univ. Agr. Exp. Sta. Bul. 965, July 1961; Ohio — Ohio Agr. Exp. Sta. Res. Cir. 29, 1956, and Res. Cir. 42, 1957; St. Louis — Mo. Agr. Exp. Sta. Res. Bul. 684, January 1959; Springfield — Mass. Agr. Exp. Sta. Bul. 507, December 1957.
[b] When not shown in the studies cited above, coefficients were computed by using income and price as the independent variables.

Table 3. — Per Capita Consumption of Whole Milk and Skimmilk Products, Per Capita Disposable Income, Nonwhites, and Retail Store Price for 55 Markets, Specific Periods, 1949 to 1961

Quintiles	Number of markets	Per capita consumption[a] 1957–1961	Per capita income[b] 1949–1959	Retail price[c] 1949–1959	Nonwhite population[d] 1960
		pounds	*dollars*	*cents per qt.*	*percent*
1	11	360	1,860	20.09	5.3
2	11	321	1,916	20.28	9.3
3	11	300	1,817	20.85	9.6
4	11	270	1,766	21.87	12.4
5	11	206	1,475	23.16	23.2
55-market average		291	1,767	21.25	11.9

[a] *Fluid Milk and Cream Consumption in Selected Marketing Areas*, U. S. Dept. Agr. Statistical Bul. 312, May 1962, pp. 12-13; and *Fluid Milk and Cream Report*, U. S. Dept. Agr., May 1962, pp. 36-37.
[b] *Survey of Buying Power*, Sales Management, yearly issues, 1950-1961.
[c] *Fluid Milk and Cream Report*, U. S. Dept. Agr., monthly issues, 1949-1959; and market administrators or handlers.
[d] *U. S. Census of Population*, 1960.

highest consumption, and so on (Table 3). Per capita income tended to decline from the first to the fifth quintile, while retail store price and percent of nonwhite population increased.

For Table 4, the same 55 markets were classified several different ways. When they were divided into three groups on the basis of per capita income, price elasticity tended to decrease as income increased. This result is in line with results of an earlier study of the New York market (Blanford).

When markets were sorted by price, coefficients of price elasticity were high, and tended to increase with an increase in price. Average price of milk was 20 cents a quart or more in 36 of the markets. For each 10-percent change in price, per capita milk consumption varied 22 percent (or more) in the opposite direction. In the 19 markets with average prices under 20 cents, consumption varied about 6 percent with a 10-percent change in price. These results are important in considering any policy that involves a change in retail milk prices.

Consumers' response to price change tended to be greater where there was a high proportion of nonwhites than where the proportion was low (Table 4).

The elasticity of demand for 24 markets in the South was substantially greater than for the other 31 markets (Table 4). For each 10-percent difference in price, per capita milk consumption varied about 12 percent in the opposite direction.

In general, retail prices were higher and incomes lower in the South than in other sections of the country.

Are quotas advisable?

Results of these studies bear directly on recent proposals to set marketing quotas for dairymen. The ostensible purpose of quotas is to hold Class I prices above their competitive level. Since present milk consumption is below that recommended by nutritionists for an adequate diet, and since the demand for milk is not highly inelastic, one may well raise the question: Would marketing quotas be in the long-run public interest?

Furthermore, it has been shown that with a retail price of 20 cents a quart or more, the demand for milk is highly elastic. This situation prevails in two out of three markets (Table 4). Is it then to the long-run advantage of dairymen to establish quotas which would not only tend to keep down per capita sales of milk but also reduce dairymen's income in at least two out of every three markets in the United States?

Table 4. — Long-Run Price Elasticity Coefficients of Fluid Milk for 55 Markets, Classified by Per Capita Disposable Income, Retail Store Price, Region, and Population[a]

Classification	Number of markets	Coefficients[b] 2 variables	3 variables
Per capita income[c]			
Under $1,730	18	−1.206	−1.425
$1,730 — $1,874	18	−.783	−.365
$1,875 and over	19	−.476	−.466
Total or aver.	55	−.658	−.625
Retail store price[c]			
Under 20¢ per qt.	19	−.805	−.574
20 to 22.29¢	18	−2.511	−2.245
22.30¢ and over	18	−2.562	−2.229
Total or aver.	55	−.658	−.625
Percent of nonwhite			
Under 5.6	18	−.785	−.420
5.6 to 13.4	18	−.386	−.421
13.5 and over	19	−.823	−.840
Total or aver.	55	−.658	−.625
Region			
South	24	−.970	−1.165
Other	31	−.321	−.300
Total or aver.	55	−.658	−.625

[a] For source of data, see Table 3.
[b] Price elasticity coefficients calculated with the two independent variables of income and price, and with the three independent variables of income, price, and percent of nonwhite.
[c] For years 1949-1959.

R. W. Bartlett, Professor of Agricultural Economics and a widely recognized authority on dairy marketing, has written several books on the subject and has served as economic consultant for governmental and other agencies.

What fossils and minerals tell us about

THE ORIGIN AND HISTORY OF SOILS

A. H. BEAVERS and R. L. JONES

ONE WAY to define soils is to say that they are complex systems of minerals, organic compounds, gasses, and solutions which are influenced by living organisms.

Illinois soils, on the average, are composed of 95 percent minerals. In our soils laboratories we are conducting a number of experiments to determine the mineral composition of Illinois soils. Knowing the nature and abundance of the minerals is important, for they are the ultimate source of plant nutrients. Further, through the study of soil mineralogy, we can learn more about the origin and history of our soils.

Considerable differences occur in the mineralogy of Illinois soils, as a result of variation in parent material, climate, vegetation, state of drainage, and relative age of the soil or length of time that the minerals have been weathered.

Parent materials

Most Illinois soils developed either directly or indirectly from materials left by the glaciers. The last two glaciers to reach Illinois were the Illinoian, which covered the entire state, except for the southernmost tip and the northwest corner; and the Wisconsin, which covered most of the northern and east-central areas.

Some soils developed directly from till where it had been deposited by the glaciers. More than 70 percent of our soils, however, developed from loess. This parent material, like till, was formed during glacial times. Melt water from the glaciers deposited fine-textured glacial material on the river flood plains. This was later picked up by the wind and redeposited as loess. As might be expected, loess deposits are thickest near the major rivers, reaching depths of about 50 feet in some areas. With increasing distance from the rivers, loess deposits grow thinner. In much of southeastern Illinois they are 4 feet or less.

Differences in clay content

Although much of our loess came from material that had originally been deposited in Illinois, we have found evidence that some of it was transported by water and wind from distant places. Part of our evidence has been obtained by studying the clay mineralogy of loess and glacial till.

Clay minerals are formed as weathering forces act upon primary or parent materials. Some of this weathering took place before the materials were deposited; some of it has occurred after deposition.

The unique physico-chemical properties of clay minerals influence nutrient- and water-holding capacity, which in turn influence soil utilization. Two of the most common clay minerals are montmorillonite and illite. Of these two, montmorillonite has the higher nutrient- and water-holding capacity.

Montmorillonite is the most abundant clay mineral in loess, whereas illite is the predominant clay mineral in till over most of the state. A striking example of this difference in clay mineral content is shown in the table. In Putnam county, where the samples were taken, more than 80 inches of loess overlie glacial till.

Clay Minerals in Muscatine Silt Loam

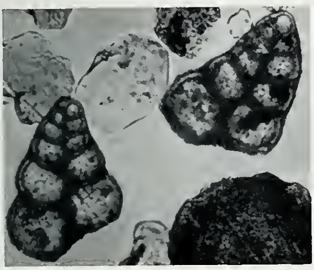
Horizon and parent material	Depth from surface	Montmorillonite	Illite	Other clay minerals
	in.	*pct.*	*pct.*	*pct.*
A (Loess) . . .	0-16	45	35	20
B (Loess) . . .	25-36	85	5	10
C (Loess) . . .	68-82	80	15	5
D (Till)	82-92	0	80	20

The illite in till was derived from bedrock in the path of the Wisconsin glacier, which came from the northeast. Montmorillonite in the loess came from sedimentary rocks as far west as the High Plains. These rocks were first eroded by glaciers and the resulting particles were transported by water and wind.

Fossils add to our knowledge

We have recently found other evidence that some of our loess originated from deposits a long way from Illinois. Studying loess through the microscope, we have found, in certain strata, very small fossils that could have originated only in sedimentary rocks to the west and northwest. These microfossils include siliceous skeletons of radiolaria and calcareous skeletons of microforaminifera (Fig. 1). The drainage pattern and glacier distribution sug-

Jones, Research Associate in Soil Mineralogy, ts a slide under the microscope. At left A. H. rs, Associate Professor of Soil Minerology, works the X-ray unit used for identifying clay minerals nalyzing chemical composition.

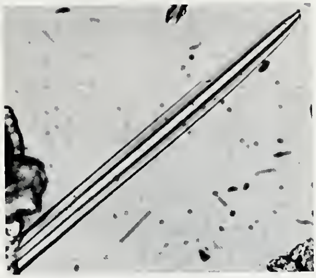


The two dark, roughly triangular, lobed fossils are microforamifera. (Fig. 1)

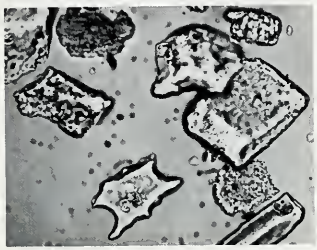
gest that these fossils may have come from as far north as Manitoba and Saskatchewan.

Fossils of local origin also occur in loess. Sponge spicules (Fig. 2) which were derived from fresh-water sponges living in Illinois streams during glacial times are fairly common. (Spicules are the very small silicious bodies that support the soft tissues of the sponges.)

Other fossils, known as phytoliths, originated from plant life. We have found opal phytoliths in loess that are identical to opal grains formed in native prairie grasses (Fig. 3). These phytoliths must therefore have originated from grasses that grew during the period of loess deposition. Opal phytoliths occur sparingly in unweathered loess, suggesting that



Long, narrow fossil is a spicule from a fresh-water sponge. (Fig. 2)



Opal phytoliths in the soil originated from native grass vegetation. This picture and Figures 1 and 2 have been magnified about 250 times. (Fig. 3)

the grass cover was sparse while loess was being deposited.

Examining surface soils, we have found the smallest concentrations of opal phytoliths in the soils closest to the major river bluffs. These soils are in the areas where loess was deposited rapidly, and the opal phytoliths are consequently spread through thick loess deposits. With increasing distance from the bluffs, deposition was slower, and the thinner loess deposits contain greater concentrations of opal phytoliths.

Since opal phytoliths are fairly stable in the soil, we believe they have a potential value as an "index mineral" in locating former A horizons that have been buried by loess and other deposits, and in evaluating the history of soil development.

Weathering of soils

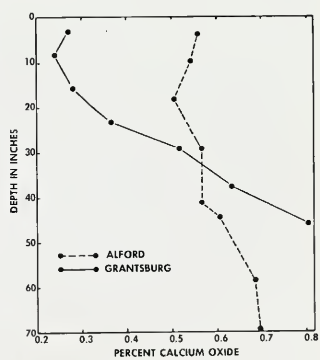
The varying amounts of material that were deposited in a given length of time greatly influenced the degree of weathering in Illinois soils. The most youthful or least weathered soils occur where loess deposits are the thickest.

Through recent studies with the X-ray spectrograph, we have been learning more about the great differences in weathering of Illinois soils. Alford and Grantsburg soils, which occur in the southern part of the state, provide a good illustration of such differences.

The degree of weathering in these two soils is indicated by the calcium contents of their profiles, for calcium-bearing minerals are not stable in the environment of southern Illinois. As can be seen from Figure 4, very little calcium has weathered from coarse-silt minerals of the youthful Alford profile, whereas weathering has progressed rather extensively through the upper 3 feet of Grantsburg, a highly developed soil.

A continuing endeavor

The examples of soil mineralogic studies which have been cited here are indicative of the continuing endeavor to learn more about the origin and development of our vital soil resource, which was aptly described by President Draper when he said, "The wealth of Illinois is in her soil and her strength lies in its intelligent development."



Much more calcium has been removed from the mature Grantsburg soil than from the youthful Alford soil. (Fig. 4)

Visitors Find Illinois Trial Garden

G. M. FOSLER

A PANORAMA of color again awaits visitors to the Trial Garden of Annuals and Bedding Plants on the University of Illinois south campus. A stop at this popular gathering place will be well worth your while — whether you're an amateur gardener or a professional plantsman, a "shutterbug" or just a sightseer.

The public is welcomed to the garden every day of the week during the long blooming season. You can enjoy the colorful display from June until frost in the fall. Most varieties, however, are at their best in July and early August. The better known forms are easily grown, can endure our rigorous summers, and are available in a wide array of colors and heights for many purposes.

A new location

This is the second year for the trial garden at its new location near the intersection of Lincoln and Florida Avenues, Urbana. The 1-acre plot is maintained by the Division of Floriculture and Ornamental Horticulture, as part of its teaching, research, and extension program.

The garden is laid out in rows with convenient cross walks, rather than in beds as part of a landscaped show garden. This arrangement facilitates proper evaluation of varieties being test-grown, as well as cultivation and other maintenance operations. As a further convenience to the visitor or student, each variety is fully labeled.

New and old varieties

Well over 1,200 different varieties are displayed this year. Seed for nearly all of them is available from retail sources. Many new varieties for 1963 are in bloom, interplanted among hundreds of the older offerings and interesting novelties. And there is a liberal sprinkling of pre-introduction items from prominent hybridizers the world over — giving visitors a preview of varieties to watch for in seed catalogs in coming years.

The much publicized 1963 All-America Selection varieties await your inspection: Zinnia *Thumbelina,* a free-flowering compact form, only a few inches tall; and Zinnia *Firecracker,* a brilliant scarlet F_1 hybrid of the popular giant cactus-flowered type. Visitors will also want to seek out several 1964 All-America Selections — not yet officially announced — among this year's plantings.

The ever-popular petunia ranks as the number one annual for Illinois conditions, and never fails to steal the show in the test garden. You'll see about 300 varieties in all, most of them F_1 hybrids. For easy comparison they are arranged both according to type (for example, F_1 Grandifloras, F_1 Multifloras) and according to color. A few of the outstanding petunia varieties which have rapidly become favorites are: *Sugar Plum, Pink Magic, Comanche, Coral Satin, Glitters,* and *Cherry Tart. Cherry Tart* represents a new class — the F_1 Multiflora Doubles, which are far more free-flowering, vigorous, and weather-resistant than the familiar large-flowered doubles.

Among the other varieties most admired by trial garden visitors last season were: Alyssum *Rosie O'Day,* Basil *Dark Opal,* Celosia *Forest Fire Improved,* Dianthus *Bravo,* Feverfew *White Stars, Fountain Grass,* Lobelia *Heavenly,* Marigold (Dwarf) *Petite Mixture* and *Spun Gold,* Marigold (Tall African) *Climax Mixture* and *Toreador,* Periwinkle *Bright Eye,* Rudbeckia *Gloriosa Daisy,* Salvia *Hot Jazz,* Snapdragon *Rocket Mixture* and *Vanguard,* and Zinnia *Old Mexico.*

Of value to many

In this, the only trial garden in downstate Illinois, varietal performance is watched closely by amateur gardeners, professional plant growers, park personnel, seedsmen, and landscapers.

From first-hand observation, the gardener can select varieties that please him and fit into his own home landscape. The florist values the garden as an aid in choosing reliable varieties to include in his production schedule the following spring. Similarly, the seedsman has the opportunity to size up varieties and decide on what catalog listings to drop or add.

Students and staff members in Floriculture and Ornamental Horticulture find the trial garden a means of keeping abreast of new developments in the bedding plant field — a very important and rapidly expanding segment of the florist industry. Important, too, is the fact that the project, aside from varietal evaluations, allows experimentation with new cultural techniques, seeding methods, and improved measures for controlling insects and diseases.

G. M. Fosler, floriculturist in the Department of Horticulture, has been in charge of the trial garden for the past 10 years.

Rudbeckia *Gloriosa Daisy*

Colorful Attraction

F_1 Multiflora Petunia *Glitters*

F_1 Hybrid Zinnia *Firecracker*

F_1 Hybrid Double Snapdragan *Vanguard*

F_1 Multiflora Double Petunia *Cherry Tart*

F_1 Hybrid Tall African Marigald *Tareadar*

Dianthus *Brava*

AGRICULTURAL AND HIGHWAY DRAINAGE LAWS

CARROLL J. W. DRABLOS

During the early settlement of Illinois, while vast amounts of land were still available, there was little or no need for drainage laws. As the population increased, however, it became necessary to settle and farm poorly drained lands, which often required extensive man-made drainage systems. The planning and construction of these systems soon led to disagreement over the rights of drainage.

While the land was being developed for agriculture, the public also demanded improved transportation facilities. With the building of roads and railroads, more questions arose like those created by the individual landowner. Thus it soon became apparent that rules and laws were needed to govern drainage rights.

Important to understand laws

A basic understanding of the laws that have developed is important for people working with agricultural and highway drainage. They should also realize that problems always involve more than one person and that each individual must accept certain responsibilities before satisfactory agreements can be reached.

Because of the growing importance of these problems, a cooperative investigation of the laws relating to highway and agricultural drainage in Illinois was initiated by the Bureau of Public Roads, the Illinois Division of Highways, and the University of Illinois. The Department of Agricultural Engineering at the University was given the responsibility for conducting the investigation.

The present article, which grew out of this study, presents a few fundamental principles embodied in the laws relating to agricultural and highway drainage.

Carroll J. W. Drablos, Research Associate in Agricultural Engineering, came to Illinois in 1959 after receiving his M.S. degree from North Dakota Agricultural College.

Two sets of rules

Drainage law is determined by two sets of rules — common and statutory. Common law has developed through long-time usage and custom, independently of any legislative action. The principles of common law are embodied in court decisions. Common law provides a large and important segment of drainage law because it applies to adjoining areas with enough difference in elevation to cause natural drainage.

Statutory laws are those enacted by the General Assembly. They generally apply where common law becomes inadequate.

Natural drainage rule

Under common law, Illinois follows the civil law rule, or what is commonly referred to as the natural drainage rule. This rule is applicable when one piece of land is higher than adjoining land, so that water flows naturally from the higher to the lower ground. The right to drain upon or over the lower land is generally the same, whether the upper land is owned by an individual or the highway authority.

The overall drainage complex is divided into watersheds or drainage areas, each of which is surrounded by a natural barrier. The area within the watershed generally feeds into a specific waterway or watercourse draining that area. The owner of higher land within a particular watershed area has the natural advantage which the elevation of his land gives him, and the lower owner must accept the surface

water flowing from the higher land through natural depressions.

If the common law limited the upper land owner to drainage only in its natural condition, the law would be of little advantage. The natural drainage rule has therefore been modified so that the upper landowner can improve the natural drainage system if such action will not create undue damages to the lower owner. For example, an upper owner may change the path of natural drainage upon his own land provided the water will empty into the original channel before it leaves his property. In other words, the water must cross the property line onto the lower owner's land at the precise point of natural drainage and at no other location.

The natural drainage rule does not allow a landowner to break down or cut through a natural barrier surrounding a particular watershed and thereby divert the flow of water into another watershed. This act is not tolerated because it would impose an additional burden on lower landowners.

The privilege of making improvements on the upper land extends to water collected in natural ponded areas within the path of natural flow. Generally the rim around a pond has a low point which allows overflow. This point of overflow is considered the natural outlet of the ponded area. It has been established that the depression can be deepened provided the pond is on a descending grade leading toward the lower land and the water from the ponded area will drain into a natural watercourse.

Discussion thus far has indicated that the owner of the higher land is within his rights to pass surface waters from his lands through natural drains upon and over the lower lands. The question that now arises is to what extent he may use artificial means to increase the flow of water upon the lower land.

According to court decisions, the owner of the upper land may install artificial drains to collect and discharge water into the natural channels on his own land, even if the quantity of water deposited upon the lower lands is increased and the flow accelerated. Two stipulations, however, must be considered: (1) Waters from the land being drained must empty into a natural watercourse draining that basin. (2) Acceleration of flow on the upper land must meet the requirements of good husbandry. These requirements have not been clearly defined in Illinois, but indication has been given that good husbandry would include any improvement in the course of bona fide farming.

If water flow were accelerated wantonly to injure the lower owner, the courts would probably restrict the acts of the upper owner.

Statutory law

Recognizing that the natural drainage rule does not always provide for a completely adequate drainage system, the state legislature has enlarged the common law by enacting statutory laws. Only a few of these laws will be discussed here.

Eminent domain laws are an example of statutory provisions. Under these laws, the highway authority may appropriate the property or the rights necessary for providing adequate drainage, but must pay a fair compensation to the owner. Before exercising the right of eminent domain, the highway authority must first try to acquire the necessary rights by gift or purchase.

A problem frequently encountered is the right of a landowner to drain into the highway right-of-way where natural drainage does not exist. The Highway Code stipulates that a landowner through or along whose land a public highway passes may drain into or along the highway provided: (1) he gives the highway authority proper notice of the work to be done within the right-of-way, and (2) he receives written permission from the highway authority.

A similar problem may occur where the highway authority installs a tile line along the highway and an adjoining landowner wants to make a connection into the tile. The Highway Code provides that the landowner may contract with the highway authority to lay a tile large enough to handle the water draining from his land. The landowner is required to pay the difference between the cost of the tile that would provide highway drainage only and the cost of the larger tile.

Before permission is granted or a contract made, the highway authority must be assured that the rules of natural drainage are not being violated and that there is a mutual understanding of the responsibility for maintaining the tile line.

Wherever there is a natural or artificial drainage system, problems of contamination and pollution may arise. The statutes provide that no one shall discharge any type of sewage, including the effluent from sewage treatment devices, or any domestic, commercial, or industrial waste into open ditches along any public street or highway, or into any drain or structure installed solely for street or highway drainage.

Although this statute has not been litigated, the Attorney General has pointed out that any waste matter which is physically offensive to the senses is included within the prohibition of the statute.

For more information

Within the scope of this article, it has been possible only to illustrate a few drainage problems and to show some of the basic framework of the law. A more detailed analysis of the laws relating to highway and agricultural drainage may be found in Illinois Engineering Experiment Station Circular 76, "Illinois Highway and Agricultural Drainage Laws."

Each drainage problem must be individually analyzed so that it may be compared with similar problems that have been brought before the courts. This requires a detailed study of the present situation and a thorough knowledge of previous court actions. For legal solutions to drainage problems, therefore, it is generally necessary to obtain assistance from competent attorneys familiar with drainage law.

NUTRITIVE VALUE OF FOODS will be increased by studies of lysine synthesis in yeast

HARRY P. BROQUIST

Now Professor of Biological Chemistry, Dairy Science Department, Harry P. Broquist was research chemist with the American Cyanamid Company until 1958. While there, he discoverd the synthesis of lysine by yeast, which has led to his present studies.

"Wherefore, I say, that such constitutions as suffer quickly and strongly from errors in diet, are weaker than others that do not; and that a weak person is in a state very nearly approaching to one in disease . . . and this I know, moreover, that to the human body it makes a great difference whether the bread be fine or coarse; of wheat with or without the hull, whether mixed with much or with little water, strongly wrought or scarcely at all, baked or raw. . . . Whoever pays no attention to these things, or paying attention, does not comprehend them, how can he understand the diseases which befall a man? For, by every one of these things, a man is affected and changed this way or that, and the whole of his life is subjected to them, whether in health, convalescence, or disease. Nothing else, then, can be more important or more necessary to know than these things."

SOCRATES made these observations more than 2,000 years ago. Yet they are pertinent even today as a basis for discussing the nutrients essential to good health. Indeed it has only been within the last half century that the amino acids making up proteins have all been discovered.

More recently, the development of adequate analytical techniques, coupled with extensive nutritional studies by investigators such as Dr. W. C. Rose and Dr. H. H. Mitchell of this University, have led to the knowledge that the proteins of meat, milk, and fish are abundant in amino acids essential for life, whereas many of the vegetable proteins, with the notable exception of legumes, may be deficient in one or more of the vital amino acids.

One such vital amino acid is lysine, a relatively simple organic molecule known as L-α, ϵ-diamino-caproic acid. It must be supplied in the diet of all higher animals, including man. Yet, as shown at the top of the next column, lysine makes up only a small part of some common vegetable proteins.

Proteins of —	*Pct. lysine*
Muscle	10.0
Milk	8.8
Blood	9.5
Soybean oil meal	6.8
Corn meal	2.3
Wheat flour	1.9
Rice	3.2

The cold analytical figures above take on sober significance when it is considered that many people in the technically underdeveloped countries subsist almost entirely on rice, corn, wheat, casava, sorghum, millet, and other cereal grains. Indeed it is estimated that perhaps two-thirds of the world's population exist on predominantly vegetable diets that are marginal in quality of protein. When viewed in the light of the present population explosion, these nutritional facts present a major problem of world significance.

Lysine supplementation studied

One possible solution, under consideration by the chemical industry, is to develop chemical or biological methods of producing essential amino acids at a low enough cost that they can be used to supplement vegetable proteins. It has long been known, for example, that the addition of lysine to wheat gluten greatly improves its biological value.

Work now in progress in the author's laboratory arose from one such industrial research project, aimed at preparing lysine suitable for food supplementation. It was found that baker's yeast efficiently manufactures lysine from α-ketoadipic acid or the closely related amino acid, α-aminoadipic acid. The substrate, α-ketoadipic acid, can be chemically synthesized from a cheap industrial chemical such as adipic acid, then converted to lysine by yeast fermentation. Lysine may make up 20 percent of the total dry weight of such an edible yeast. By adding a "high lysine" yeast to flour for bread, it thus becomes possible to increase the nutritive value of the "staff of life."

How is lysine synthesized?

The discovery that yeast enzymes can convert α-aminoadipic acid to lysine raised questions as to the precise manner in which this is accomplished. Detailed knowledge of the process could be important both from a practical and from a theoretical standpoint. The process is

therefore being investigated in the Laboratory of Biochemistry, Department of Dairy Science.

Seemingly, the transformation of α-aminoadipic acid to lysine involves only changes of the substituents about the δ-carboxyl (COOH) group (Fig. 1). From previous biochemical studies, a logical mechanism for the changes may be deduced: Presumably the δ-carboxyl group is reduced to α-aminoadipic-δ-semialdehyde, then aminated to give lysine, as shown in Figure 1.

Through experimentation, we have obtained indirect evidence that aminoadipic semialdehyde is indeed involved in the biosynthesis of lysine in yeast. What we presumed to be aldehyde was trapped in yeast cells as an orange-colored compound. Chemical analysis identified it as a derivative of aminoadipic semialdehyde.

We have found in yeast some cell-free enzymes which form the semialdehyde from aminoadipic acid, provided certain catalysts are present. These catalysts are adenosinetriphosphate (ATP), triphosphopyridine nucleotide (TPNH), glutathione, and magnesium ion.

Some Japanese investigators have performed the same experiments, and they have postulated that Reaction A, Figure 1, likely consists of two steps rather than one. Their theory is that α-aminoadipate is first activated by ATP and then reduced via TPNH to the semialdehyde (Fig. 2). Further work is needed, however, to support this hypothesis.

Current studies at the University are concerned with the manner in which α-aminoadipic-δ-semialdehyde is aminated to give lysine (Reaction B, Fig. 1). Here again we have found that the mechanism involved is more complex than at first believed. When radioactive aminoadipic acid was added to yeast suspensions capable of synthesizing lysine, an unknown radioactive substance, termed Compound B, accumulated briefly. As lysine was formed, the amount of Compound B decreased, indicating it was a precursor of lysine.

Later, enough Compound B was isolated that we could study its chemical structure. It was found to be ϵ-N-(glutaryl-2)-L-lysine. This is a derivative of lysine in which the ϵ-carbon atom bears a secondary amine with the N atom bonded to glutaric acid (Fig. 3).

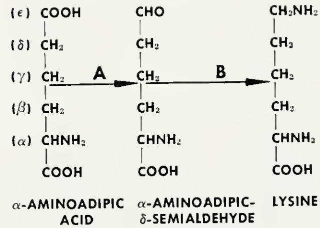
From work now in progress with cell-free enzymes from yeast, it appears likely that glutamate condenses with α-aminoadipic-δ-semialdehyde, ultimately forming Compound B, or ϵ-N-(glutaryl-2)-L-lysine. The latter may then undergo cleavage to give lysine and α-ketoglutarate (Fig. 3).

The discovery that ϵ-N-(glutaryl-2)-L-lysine participates in lysine biosynthesis was unexpected. It is of considerable theoretical interest, as it provides another example of a novel mechanism for introducing a nitrogen atom into a molecule via the participation of a dicarboxylic amino acid.

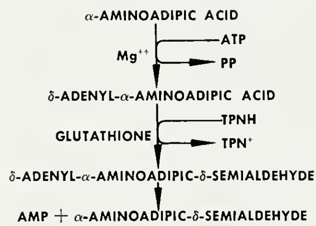
"Applied" and "pure" research are inseparable

These studies illustrate the futility of attempting to draw a hard and fast line between "applied" and "pure" research. Although the experiments were initiated to explore an economical process for lysine production as a nutritional supplement, they are leading to a more intimate understanding of a series of previously ill-understood biochemical transformations. On the other hand, when the precise enzymatic steps in this particular biochemical sequence are established, we will be able to analyze the levels of these enzymes in lysine-deficient plant proteins.

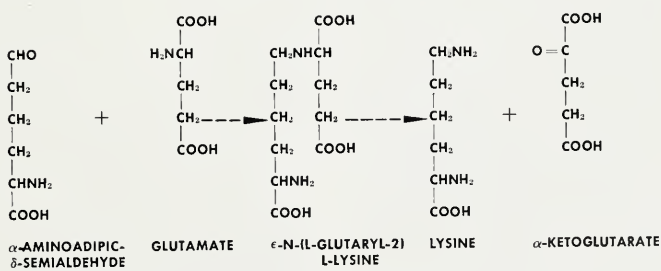
Corn contains α-aminoadipic acid, for example, yet is notoriously low in lysine. It would be extremely enlightening to pinpoint the enzymatic deficiency in corn that may limit lysine formation from aminoadipic acid. Such knowledge would suggest cross-breeding experiments by which one could hope to develop strains of corn with enhanced ability to synthesize lysine.



A generalized mechanism of lysine formation from α-aminoadipic acid. (Fig. 1)



Mechanism of α-aminoadipic-δ-semialdehyde formation as postulated by Sagisaka and Shimura (Sympos. Enz. Chem. 15). (Fig. 2)



Postulated scheme of lysine formation from α-aminoadipic-δ-semialdehyde. Dotted arrows indicate possibility of other intermediates. (Fig. 3)

GOOD MARKETS FOR ILLINOIS GROWERS OF CHRISTMAS TREES

T. W. CURTIN

Now is the time for Christmas tree growers to think of marketing next winter's crop. Trees must be sold when they've reached the size the consumer wants; otherwise they may outgrow the market.

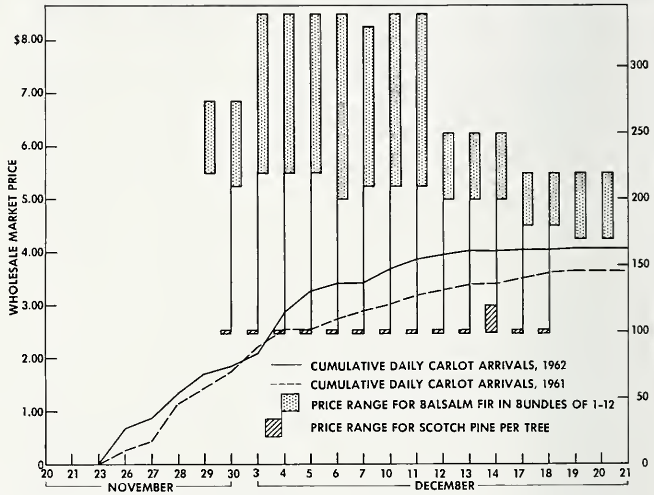
Fortunately, Illinois producers are relatively close to major outlets. These include not only the metropolitan areas of Chicago and St. Louis, but also the Quad Cities, Rockford, Peoria, Springfield, and many other smaller cities. Producers between Chicago and St. Louis are in especially good position to choose the better market.

In season, daily reports on Christmas tree trends are given in the Fresh Fruit and Vegetable Market News, issued from both Chicago and St. Louis by the U. S. Department of Agriculture. (Addresses are 942 U. S. Court and Custom House, St. Louis 1; and Room 1060, 610 S. Canal St., Chicago 7.)

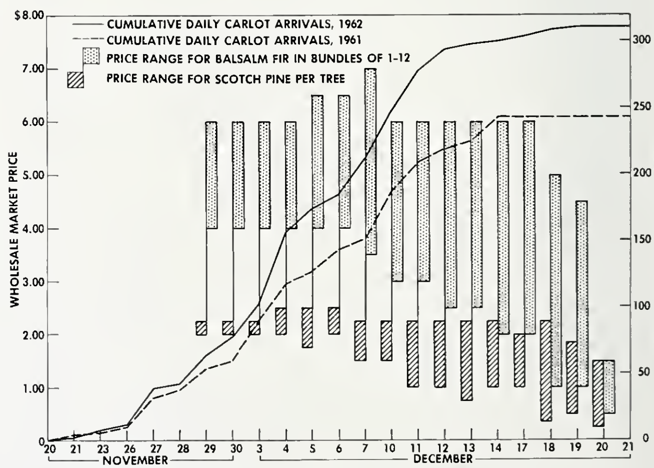
The graphs at right are a composite of last year's data. It can be seen that St. Louis was the stronger Scotch pine outlet in 1962. If a producer was caught with unsold trees, even at mid-December, St. Louis offered him an attractive and relatively steady price of about $2.50 a tree. Higher balsam fir prices at St. Louis, probably because of longer shipping distances, undoubtedly influenced the Scotch pine market.

Other information on the economics of Christmas-tree farming may be found in "Christmas-tree farming can be a profitable enterprise," Illinois Research, Fall, 1961.

T. W. Curtin is Instructor in Forestry Extension.



Summary of Christmas tree arrivals and wholesale prices at St. Louis.



Summary of Christmas tree arrivals and wholesale prices at Chicago.

Bacteria That Live in the Refrigerator

L. D. WITTER, Y. AZUMA, and S. B. NEWTON

STORAGE at low temperature is one of the oldest and most widely used methods of food preservation. Lowering the temperature reduces the rate of chemical decomposition. It also decreases bacterial spoilage because most bacteria that can spoil food cannot reproduce at refrigeration temperatures.

A unique and fascinating group of bacteria, however, are capable of reasonably rapid growth when temperatures are low. These bacteria are called psychrophiles, a word derived from the Greek words *psychros,* meaning cold, and *philos,* meaning loving, hence cold-loving.

Psychrophiles limit the keeping quality of refrigerated foods and dairy products. Their importance to the food industry has been accentuated in recent years by advancements in refrigeration facilities, increased regard for keeping quality, and longer holding times resulting from transportation of food items over greater distances.

Spoilage by psychrophilic bacteria is manifested in a large number of possible defects. A few of these are: rancidity in fat-containing foods, putrid odors in protein foods, soapy flavor, and skunk-like, sweaty-feet, and fishy odors. An objectionable slime or a variety of colorations and discolorations may develop on meat and cottage cheese.

Psychrophilic bacteria are of further importance because they contaminate refrigerated blood-bank blood, they are prominent in the flora of marine environments, and they help cause the decomposition of house paints.

Besides being of great practical importance, psychrophiles are also of great academic interest, since they pose the yet unexplained phenomenon of growth at low temperature. Hence, psychrophilic bacteria serve as a convenient model system for studying and understanding the intrinsic factors involved in the performance of any biological material subjected to low temperatures.

Pairs of bacteria needed

A fundamental problem is why psychrophiles can grow at low temperatures while nonpsychrophilic bacteria cannot. The solution is to be found by comparing the responses of psychrophiles and nonpsychrophiles to variations in temperature and revealing the factors responsible for differences in these responses.

Clearly, the first step in the study of this problem is to obtain an appropriate pair of bacteria on which to experiment. Ideally, the psychrophile and nonpsychrophile to be compared should be identical except for the psychrophile's ability to grow at low temperature and the characteristics which bear directly upon this ability. Unfortunately, such an ideal pair of bacteria is not available and to screen the thousands of strains of known bacteria for this ideal pair would be physically impossible and probably unsuccessful. Hence, this study was initiated to determine if, by ultraviolet irradiation of a nonpsychrophile, we could produce a genetic mutation which would change the bacterium into a psychrophile.

Three new psychrophiles

Heavy cell suspensions of 10 different nonpsychrophilic bacteria were irradiated for 1 minute at 15 centimeters from a 15-watt ultraviolet lamp. The irradiated suspensions were diluted with phosphate buffer at pH 7.0, streaked on the surface of trypticase soy agar, and incubated at 43° F. Any bacterial growth appearing on the surface of the agar in 48 hours was considered to be that of a potential psychrophilic mutant. Potential psychrophilic mutants were then isolated and grown at 32° F. on the surface of trypticase soy agar that contained glycerol to prevent the medium from freezing.

By this procedure a psychrophilic mutant was obtained from each of three nonpsychrophiles. The parent cultures were different strains of *Pseudomonas aeruginosa.* None of them produced visible growth on trypticase soy agar in 10 days at 50° F. The three psychrophilic mutant cultures, however, produced visible growth on trypticase soy agar in 2 days at 50° F. and in 8 days at 32° F. Apart from the ability to grow at low temperature, each psychrophilic mutant was indistinguishable from its nonpsychrophilic parent.

This was the first time that psychrophilic bacteria had been produced from nonpsychrophiles. Mutagenic agents such as ultraviolet irradiation had not been previously tried. Attempts had been made to train bacteria to grow at progressively lower temperatures, but these had not produced psychrophiles.

The three pairs of bacteria, each pair consisting of a nonpsychrophile and a psychrophilic mutant of the nonpsychophile, are the ideal test organisms toward which this search was directed.

Future plans

Establishment of these ideal test bacteria is only the first step in solving the fundamental problem of why some bacteria grow at low temperatures and others do not. The next step is to discover the differences in these test pairs and hence the characteristics that are responsible for the psychrophiles' ability to grow at low temperature. This question is now being investigated at the University of Illinois, at four other laboratories in the United States, and at two laboratories abroad. These other laboratories have requested and received the ideal test pairs developed at Illinois. In this way all investigators of the problem can profit by the progress of others.

L. D. Witter is Associate Professor; Y. Azuma, Research Associate; S. B. Newton, Assistant, Department of Food Technology.

RESEARCH IN BRIEF

School Children Sing Better When They Have Been Trained in Nursery School

In a vocal research project begun at the Child Development Laboratory in 1958, entire nursery school groups were taught to sing for at least two semesters. Practically all the children learned to sing with accuracy, indicating that vocal training should be included in nursery school programs (see ILLINOIS RESEARCH, Summer, 1960).

The trained groups are tested again each year in elementary school. One purpose is to determine whether the children maintain their previous level of vocal accuracy. Their performances are also compared with those of other children who are the same age and have similar backgrounds but who did not have the same type of training in nursery school.

The tests were held for the fourth year this spring. More than 1,200 pupils in 50 classrooms participated in a three-day training period. Later 200 children completed short singing tests, which were tape-recorded and graded.

The value of early vocal training was again brought out by the performances of children who had been trained in nursery school. All the trained second- and third-graders and all but two of the first-graders sang with complete accuracy.

Children who had not received equivalent nursery school training were not as accurate. The oldest group tested — the third-graders — performed least well. Almost 30 percent of these children were very poor singers. Only 10 percent of the second-grade group fell into a similar category.

Each year classroom teachers receive a report on the results of the testing, together with suggestions for improving their vocal program. This information has apparently helped the younger untrained groups. — *Robert B. Smith*

Fungus Spores Are a Complex Chemical Machine

Germination of fungal spores has, in the past, been conceived as a simple process, depending primarily on the absorption of water by this microscopic "seed." It was thought that, as the spore wall weakened under the water's pressure, the protoplasm pushed out to form the "germ tube" — a tiny thread that is the beginning of true growth.

Something is wrong with this simple picture, however, for very few fungi can germinate in water. According to our current research, germination depends upon the evolution of energy by the spores, and upon the synthesis of cell materials. Consequently sources of carbon and oxygen are necessary. The carbon is usually a carbohydrate like sugar or else fat. Sometimes the spore already contains enough carbon for its vital activities. This is true of the rust fungi of wheat and beans. More often the usable carbon in the spore is insufficient, as in corn smut, and has to be absorbed from the environment.

To produce energy from the carbohydrates, a large number of enzymes are needed, and many of these have been found in the spore. Sometimes enough are present that energy is readily produced and a germ tube is formed in a short time. In other cases, more enzymes must be made before germination can even begin. Corn smut is unusual since many of the enzymes are absent and they have to be synthesized by the spore before a germ tube is formed.

The enzymes needed for energy production are proteins, and therefore spores must have nitrogenous materials to form protein. Spores usually have enough stored nitrogen for this purpose, although sometimes an external source is needed. Protein formation requires carbon compounds as well as nitrogen, and these have to be synthesized by the spores.

Obviously spore germination is not a passive process, but is a vital phenomenon, as complex as in other phases of growth. A full supply of nutrients is needed for the biochemical processes involved in producing enzymes for energy and for cellular synthesis. Water must be absorbed to dissolve external nutrients and to dilute the concentrated cell constituents to a level that is best for the general metabolism. Only after these processes have begun, can the spore send forth its germ tube and begin growth. — *David Gottlieb*

Four Types of Interfacing Are Tested in Two Cotton Double-Knit Fabrics

Since cotton double-knit fabrics have recently become available for the home sewer, the Department of Home Economics has been studying the suitability of different interfacings for these fabrics.

The study involved two cotton double-knit fabrics and five lightweight interfacings. These included both woven and non-woven types in both iron-on (adhesive-bonded) and non-adhesive fabrics.

Two sets of half-scale Chanel style jackets were constructed from each double-knit fabric. Each set included three jackets. One half of one jacket in each set was made without an interfacing and the other five halves were constructed with the various interfacings.

One set of jackets of each double-knit fabric was laundered five times, while the other was not washed. All jackets were then rated for appearance and suitability of the interfacings for the fabric.

All the interfacings except the

woven, non-adhesive type were considered too stiff for use with these double-knit fabrics. Both iron-on types caused very great stiffening of the jacket fronts when they were bonded to the double-knit outer fabric.

Washing caused excessive shrinking of the double-knit fabrics, especially in the wale direction. Most of the interfacings shrank very little in either direction. Because of this great difference in shrinkage, the washed jackets had a puckered or lumpy appearance.

The iron-on interfacings controlled the knit shrinkage better than the non-adhesive types, but this caused differing amounts of shrinkage between the parts of the jacket which were interfaced and those which were not. — *Ruth Legg Galbraith and June Hefter*

Adaptability of Conifers in Southern Illinois

Coniferous species are generally planted on the eroded and abandoned farmland of Illinois because they don't have the high site requirements of the more desirable hardwood species.

An 18-year-old plantation of loblolly pine in southern Illinois.

During the 1930's shortleaf pine was chosen for reforestation because it was native to southwestern Illinois and would produce acceptably sized stems for forestry purposes. The federal government at that time planted many acres with this species.

Since then, other species have been planted with relative success. Fifteen species are now being grown at the Dixon Springs Experiment Station to investigate their adaptability in southern Illinois. They were planted in March, 1941, at a spacing of 6 by 8 feet on an old field containing Korean lespedeza and redtop. Drainage, both surface and internal, was considered average for the area.

After one year, survival of all 15 species was excellent, most of them being 90 percent or better. By 1962, after 22 growing seasons, survival had dropped, as indicated by the figures below. These give measurements for the four species which seem best adapted to the locality.

Species of pine	*Survival percent*	*Av. diam. at 4½ ft., inches*	*Av. height, feet*
Loblolly . . .	63	9.9	40
Shortleaf . .	88	6.9	37
White	72	5.5	32
Austrian . . .	74	5.2	33

Although it would be better to wait 20 more years before selecting species, our present results indicate that loblolly and shortleaf pines are the best coniferous species for old fields in this area. — *W. A. Geyer and A. R. Gilmore*

Low-Moisture Silage Proves a Satisfactory Feed for Dairy Cows

Low-moisture silage made in conventional silos has as much feeding value for dairy cows as hay or regular silage. This is assuming that all three forages are made from the same crop and are of excellent quality.

In a recent study the three forages were made from a first-year stand of a DuPuit alfalfa-orchard grass mixture. The crop was cut when the alfalfa was at the bud stage, and a conditioner was used. Regular silage was stored in a conventional tower silo at a dry-matter content of 33.75 percent; and low-moisture silage, at a dry-matter content of 50.48 percent.

Fifteen lactating cows were divided into three equal groups, each group receiving one of the three forages for 56 days. In addition, the cows were fed 1 pound of grain for each 3 pounds of 4-percent fat-corrected milk produced. Forage dry-matter consumed was 26.2, 23.7, and 24.6 pounds for the hay, silage, and low-moisture silage, respectively. Production of 4-percent fat-corrected milk was 47.2, 44.3, and 46.1 pounds. Body weight changes were 32.6, 43.0, and 24.6 pounds. None of the differences were significant.

In this first-year study, no attempt was made to measure dry-matter losses from the silo, as the material was fed as soon as the silos were filled.

The following year, however, we measured dry-matter losses from a conventional silo after 5 weeks of storage. As in the first year, the alfalfa had been cut at the bud stage and a conditioner used. The low-moisture silage had been stored at 59.6 percent dry matter. It had been sealed with a plastic cover plus about 8,000 pounds of direct-cut material on top of the plastic.

No spoilage was observed when the silo was opened. Total dry-matter loss was 14 percent, of which 8 percent was in the direct-cut material and only 6 percent in the low-moisture silage. This is a reasonable fermentation loss for most silages in tower silos. Lactating cows ate about the same amounts as in the previous year.

Making low-moisture silage requires care. The material should be cut at the bud stage, treated with a conditioner, and chopped finely. It should be spread evenly in the silo and packed well to exclude air. If the material is not fed out immediately, it should be sealed tightly with plastic or direct-cut material. — *J. H. Byers*

FARM BUSINESS TRENDS

ONE of the brightest spots in the nation's agricultural situation is the strong and growing demand for meat, especialy beef. The three charts on this page show several important facts about the market for pork and beef, our two principal meats.

Two points may be emphasized from Figure 1:

1. Retail prices of pork do change when the supply changes. Notice the scissor-like movement of the lines representing supply and price. Prices rose in years when supplies decreased, and fell when supplies went up.

2. Consumption (supply) of pork per person has not changed much in the last 10 years, although it has not been as great as it was in 1950-1952.

Similarly, two facts stand out in Figure 2:

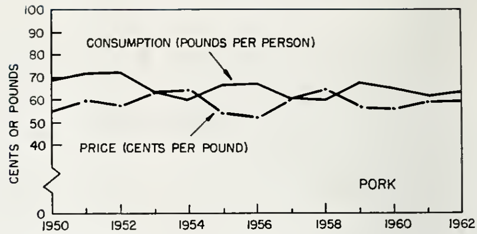
1. Retail prices generally went up when supplies diminished, and turned down when beef became more abundant.

2. Over the entire period both consumption and prices of beef trended upward. Consumption went up from 63 to 89 pounds per person, while average price rose from 69 to 84 cents a pound. It is an unusually fortunate situation when larger supplies can be sold at higher prices.

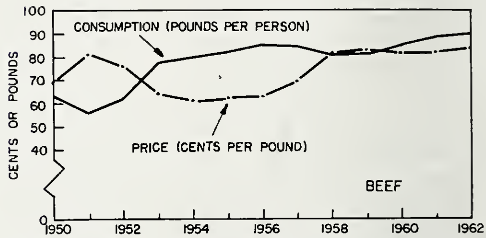
As shown in Figure 3, the retail value of pork consumed trended downward from 1951 to 1956, but has been holding up well in the past 6 years. Retail value of beef consumed per person went up in 12 of the 13 years shown. It increased from \$35 in 1950 to \$55 in 1962.

Figures for consumption and total retail value are per person. Thus they do not show the effects of population growth, which is about 1⅔ percent a year.

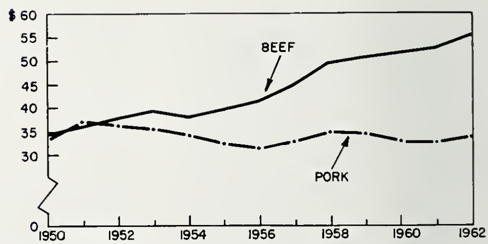
(This article is based upon figures published by the Economic Research Service of the U. S. Department of Agriculture in Livestock and Meat Situation, May, 1963.) — *L. H. Simerl, Professor of Agricultural Economics*



PORK: Consumption per person and price per pound. (Fig. 1)



BEEF: Consumption per person and price per pound. (Fig. 2)



BEEF AND PORK: Retail value of amounts consumed per person, 1950-1962. (Fig. 3)

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ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

IN THIS ISSUE

Improved pumpkin varieties may be harvested in the future as the result of reversing evolution (page 3).

Volume 5, Number 4 UNIVERSITY OF ILLINOIS COLLEGE OF AGRICULTURE URBANA, ILLINOIS

ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

CONTENTS

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DEANS OF THE COLLEGE OF AGRICULTURE: JOSEPH C. BLAIR

Joseph C. Blair, fourth Dean of the College of Agriculture, is known as "the father of Illinois state parks." A co-founder and first president of the Illinois Association of Park Districts, he was largely responsible for the restoration of Fort Massac, the first state park. In 1907, he organized the Urbana Park District (Blair Park is named in his honor), and served as a member of the board for 42 years, including 29 consecutive terms as president. During his long lifetime, he worked unceasingly to beautify his adopted state, especially Urbana and the University campus, where he planted 10,000 trees and shrubs.

But perhaps Dean Blair's outstanding achievement is the development of the Department of Horticulture at Illinois. Under his leadership, the Department became internationally known for its research publications in pomology, vegetable crops, and floriculture. Blair established the first four-year curriculum in floriculture and one of the best landscape architecture courses in the United States. For his contributions to horticulture, he received honorary degrees from Iowa State University and the College of Wooster (Ohio).

Dean Blair was born on a farm in Colchester County, Nova Scotia, in 1871. He attended the Provincial College of Agriculture at Truro, Nova Scotia, from 1888 to 1890, and taught chemistry, zoology, and botany there until 1892. For the next four years, Blair attended Cornell University, majoring in chemistry, entomology, and horticulture. He came to the University of Illinois in 1896 as an instructor in horticulture under Dr. T. J. Burrill, and was made head of the newly created Department of Horticulture in 1900. Upon the death of H. C. Mumford in 1938, Blair was appointed Dean of the College. He served in that position until his retirement in 1939.

When Dean Blair died in 1961, the resolution presented to the faculty of the College contained these words: "Dean Blair will be remembered as a man whose vision and lifetime efforts were directed to making the world, and especially his state and home community, better places in which to live." — *Richard G. Moores*

BETTER PUMPKINS by reversing evolution

ASHBY M. RHODES

PUMPKIN OR SQUASH?

All edible members of the genus *Cucurbita* may be considered squash. However, the round orange fruits used for jack-o'-lanterns and pies are generally called pumpkins. Large-necked, bottle-shaped fruits are sometimes referred to as cushaws. Ornamental, hard-rind cucurbits are gourds.

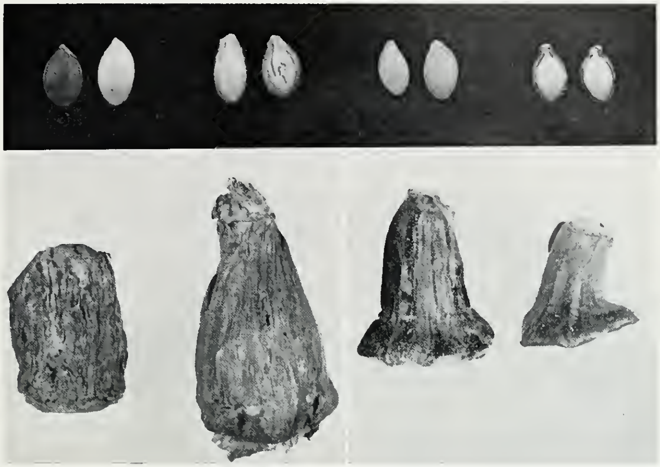
MAN has cultivated pumpkin and squash for centuries. Cave dwellers of Mexico were using the fruits over 5,000 years ago. By the time of Columbus, pumpkin and squash were being grown for food over much of what is now the United States.

After many centuries of evolutionary process, the pumpkin family (genus *Cucurbita*) contains a large assortment of plant characters, which offer the possibility of new combinations for better varieties. As this genetic variability has developed, however, crossing the related plants of the pumpkin family has become more difficult.

Evolution can be compared with a game of cards in which Mother Nature has made the rules and dealt out the hands. The genes found in *Cucurbita* may be considered the deck of cards. Real cards are recognized by their suit and number or picture. Genes cannot be seen, but are recognized by their effects on individual characters, especially in the seed and peduncle (fruit stem).

Just as certain combinations of cards produce a winning hand, so certain combinations of genes survive as species. In the United States, the four annual cultivated species of *Cucurbita* are *C. moschata, C. maxima, C. pepo,* and *C. mixta.*

C. moschata, our oldest species, has a yellow to dark orange flesh with a fine to coarse grain. Typical varieties are the bell-shaped Butternut squash and the large-fruited Dickinson Field pumpkin. *C. maxima* has a yellow, fine-grained flesh and includes Blue Hubbard, Pink Banana, and the turban-shaped Buttercup varieties of squash. *C. pepo* has a coarse flesh, ranging in color from white to yellow-orange depending upon the variety. Connecticut Field, the traditional jack-o'-lantern pumpkin, and Royal Acorn squash are well-known fall varieties. Summer varieties include Yellow Crookneck and Zucchini squash. Also found in this species are the yellow-flowered gourds.



Seeds and fruit stems (peduncles) of *C. maxima, C. mixta, C. pepo,* and *C. moschata.* The following key is given as a further aid in identifying these four species:

	Corky fruit stem	Noncorky fruit stem
Smooth seed margin	*C. maxima*	*C. pepo*
Scalloped seed margin	*C. mixta*	*C. moschata*

C. mixta varieties were considered as part of *C. moschata* until 1930, when specific characters were recognized as distinct enough to warrant a new name for this group. The flesh is coarse and is white to yellow. Varieties include the Green-striped Cushaw; Japanese Pie, in which the seed coat is split into oriental patterns; and White Cushaw, whose large fruits resemble the schmoos in "Li'l Abner."

Redeal

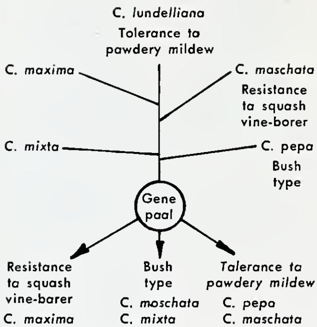
Rules of a card game prevent us from exchanging cards from one hand to another after the cards have been dealt. The exchange of genes by crossing species is prevented by sterility barriers that have arisen during the course of evolution.

But if we can't exchange cards, we can sometimes redeal them to get a new and possibly better hand. Before redealing, all hands are put back in the deck and reshuffled. Can we redeal genes to get a new species or perhaps improve an old one? In other words, can we reverse evolution in *Cucurbita* to a time before

Ashby M. Rhodes, Assistant Professor of Horticulture, has been with the University since 1951.

species evolved, and then reassemble the species into new or improved forms?

Fortunately, this idea of reversing evolution became a possibility when Whitaker of the U. S. Department of Agriculture discovered that *C. lundelliana,* a wild species from southern Mexico and Central America, was cross-compatible with our cultivated species. *C. lundelliana* is comparable to the remainder of the deck after all hands are dealt. Because it could be crossed with other species, the genes from several species could be reassembled into a common gene pool just as we might reassemble a deck of cards.



Schematic diagram of how a gene pool is formed and can be used to transfer genes from one species to another.

The gene pool was begun in 1956, when *C. lundelliana* was crossed with *C. moschata* and with *C. maxima.* These crosses were self-fertile and also cross-fertile with their parent species and with other species. By carefully intercrossing the different species, with *C. lundelliana* serving as a bridge, we have developed our gene pool or interbreeding population. Genes from one species, having been transferred to the pool, can now be retransferred to another species.

New bush pumpkins

Through the gene pool, the genes that control the bush form of growth in *C. pepo* are being transferred to the Dickinson Field variety in *C. moschata.* This variety is used by the Illinois canning industry, which processes about 60 percent of the nation's pumpkin.

The plant is a vining type. Fruits are set well away from the center of the row and must be wind-rowed before being mechanically loaded. If they were on a bush plant, they would be near the center of the row and would not have to be windrowed.

We began the transfer of genes by selecting several bush plants from the gene pool and crossing them with Dickinson Field. Since the bushy plant character has a recessive type of inheritance it did not appear in full form in the first or F_1 generation after the cross. All plants of the F_1 generation contained both genes for vine growth and those for bush growth, but genes for vine growth partially dominated the others.

Both vine and bush plants appeared in the second or F_2 generation, since some of the plants did not carry the dominant genes for vining. The bushiest plants from the F_2 generation were crossed with Dickinson Field. The cycle, which is called backcrossing, will be repeated until the fruits of the bushy plants are like those of the vine plants. The only difference, then, between the old and the new Dickinson Field will be in form of growth.

Other possibilities

As an extra bonus to our gene pool, *C. lundelliana* is tolerant to powdery mildew. This tolerance is being transferred to *C. moschata* and *C. pepo.* Tolerance to powdery mildew is inherited as a dominant character. Every generation in our backcross cycle will therefore have some disease-resistant plants, instead of every other generation as in our bush-transfer cycle.

By reversing evolution, we have made progress in improving *Cucurbita* varieties. This method of breeding could well be used to improve other crop plants in the future.

Beginning of the gene pool. Top center fruit is *C. lundelliana.* Other fruits are species hybrids with *C. lundelliana* as the common parent.

Advanced-generation gene pool. Seeds from these fruits will be planted for the following year's pool.

Can you help in the search for a wild relative of corn?

R. J. LAMBERT

A LITTLE-KNOWN but important relative of corn may be growing wild very near your home.

This relative is a perennial grass known as *Tripsacum dactyloides* (L.) or gama grass. Both *Tripsacum* and corn belong to a tribe of grasses known as Maydae. Many research men believe that *Tripsacum* has played a role in the evolution of present-day corns. Supporting this hypothesis is the fact that the two species can be hybridized quite easily by special techniques.

The success of hybridization has prompted Dr. Jack Beckett and the author to conduct a survey of *Tripsacum* distribution in Illinois. Herbarium records and published reports have served as guides.

During the two years that the survey has been going on, we have collected material from 23 different sites in 14 central and southern Illinois counties (Fig. 1). These sites include 14 that were already known and 9 new ones.

Sites of *Tripsacum dactyloides* collection in Illinois: 1, Urbana; 2, Stonington; 3, Harvel; 4, Carlinville; 5, Shipman; 6, Horseshoe Lake; 7, Carlyle; 8, Huey; 9, Shattuc; 10, Sandoval; 11, Patoka; 12, Shobonier; 13, Alma; 14, Olney; 15, Freeman Spur; 16, Herrin; 17, Murphysboro; 18, Opdyke; 19, Metropolis; 20, Pinckneyville; 21, Beckemeyer; 22, Watson; 23, Elkville. (Fig. 1)

Cuttings from each site are being grown on the Agronomy South Farm at Urbana. Individual plants are being tested for ability to hybridize with corn. By pollinating shortened corn silks, we have obtained 19 hybrids. Seven of the hybrids resulted from pollination of only 18 ears by a clone from the Sandoval area in Marion county. Backcrossing these hybrids to corn will permit us to evaluate the contribution made by *Tripsacum* germ plasm.

According to preliminary observations, *Tripsacum* is resistant to leaf rust, northern leaf blight, and other diseases that attack corn. This resistance, as well as any other desirable agronomic characters found in *Tripsacum*, may be transferable to corn. It may even be possible to give corn the perennial growth habit of *Tripsacum*.

A typical *Tripsacum* plant is shown in Figure 2. The plant is usually 4 to 8 feet tall. It is mostly found in low, moist places, especially in road ditches, along railroads, and in waste areas. The species does not appear able to survive well in cultivated fields.

The plant is best identified when it is in flower (Fig. 3). The upper portion of the flower produces red or yellow anthers similar to those of corn. Red or colorless silks are produced on the lower part of the flower.

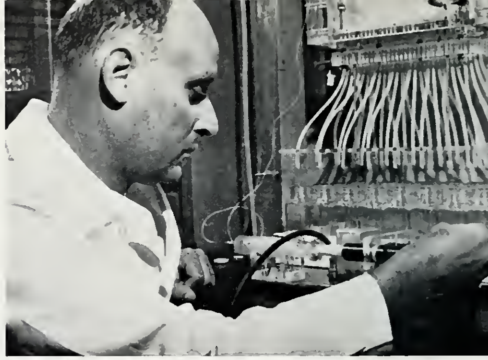
Because of extensive road-improvement and land-drainage programs in Illinois, *Tripsacum* may become extinct in the state. We would therefore like to receive any reports of the location of *Tripsacum* in Illinois. In particular, we would like to hear from anyone who finds *Tripsacum* in the following areas: Spoon River bottom, Fulton county; Kickapoo Prairie, near Washington, Tazewell county; northeast of Chauncey, Crawford county, or in Lawrence county; Olney, Richland county; Mt. Carmel, Wabash county; Augusta, Hancock county; Yale, Jasper county.

Typical *Tripsacum* plant. (Fig. 2)

***Tripsacum* in flower. (Fig. 3)**

R. J. Lambert is Assistant in Plant Breeding, Agronomy Department.

ANIMALS' remarkable defense against foreign substances in their bodies



Blood serum of pigs is tested by Diego Segre, Professor of Veterinary Microbiology, Public Health, and Veterinary Research.

DIEGO SEGRE

A MOST REMARKABLE endowment of vertebrate animals is their ability to defend themselves against foreign substances in their bodies.

These foreign substances are known as antigens. Generally they are large protein or carbohydrate molecules. When they enter an animal's body, the animal responds by synthesizing protein molecules called antibodies, which are found in the globulin fraction of blood serum. The shape of the antibody molecule complements that of the antigen molecule, so that the two are bound together somewhat as a key fits into a lock.

Some antigens are infectious, being introduced into the body through pathogenic agents such as bacteria and viruses. The antibody that a host manufactures against a disease antigen can give the host a specific immunity to subsequent attacks by the same pathogen.

Many antigens, however, are not infectious. A rabbit, when injected with blood serum from a cow, will produce antibodies that combine with the proteins in the bovine serum. Similarly a calf will manufacture antibodies against rabbit serum proteins. Neither animal, however, will form antibodies against its own serum proteins.

"Self" and "non-self" recognized

The animal's body can thus distinguish between foreign, antigenic substances and its own components, which are not antigenic for that animal even though they may be antigenic when injected into animals of other species. In other words, animals possess a mechanism for distinguishing between "self" and "non-self."

Little is known about this recognition mechanism. We do know, however, that it must be absent or deficient in unborn or very young animals. A newborn or embryonic animal can be injected with large amounts of an antigen without developing antibody. Moreover, when this animal is an adult, it still won't form antibody when it is injected with the same antigen.

In this instance the recognition mechanism has failed. The animal has been fooled into accepting as "self" a substance which it should have recognized as "non-self." This phenomenon has been called immunologic tolerance.

Since immunologic tolerance generally results from exposure to the antigen during embryonic or early life, it has been reasoned that the recognition mechanism must develop at that time. But how does the mechanism operate? One theory, originally proposed by Dr. N. K. Jerne of the World Health Organization, has been found to accord with experimental results at the University of Illinois.

Jerne uses this analogy: Suppose that a person, whom we shall call Mr. X, enters a room filled with people who speak many languages. Mr. X wants to find out who in the room speaks English. This he can do in one of two ways. Either he understands English, in which case he can go about the room listening to the conversations until he finds someone who is speaking that language. Or Mr. X does not understand English, but does understand all other languages. He would then know that the people whom he does not understand must be speaking English.

The first case would be equivalent to the organism's recognition of "self." The second case would be recognition of "non-self." This second possibility is more attractive for various reasons. For one thing, it would be strange indeed if the immunologic apparatus, having recognized a "self" component, would do nothing about it. It is more satisfying to imagine that the apparatus, after recognizing a "non-self" component, proceeds to make antibodies against it.

How is recognition achieved?

We now turn to the question of how "non-self" is recognized. If Mr. X is to recognize all foreign words spoken in the room, he needs a dictionary listing all these words. Like Mr. X, the animal needs some device for recognizing all foreign antigens.

There is no better candidate for this job than antibody itself, which by definition can combine specifically with, and thus must recognize, its corresponding antigen. We shall therefore postulate that an animal possesses a full complement of preformed, natural antibodies corresponding to all the antigens against

which it is capable of reacting. The concentrations of natural antibodies must be too low to be detectable by the usual serologic tests. We shall also postulate that natural antibodies directed against self-constituents are absent. Finally, additional antibodies can be produced only after the antigen has been recognized as "non-self" by the corresponding antibody.

The trouble with the above theory is that the animal would have to have prior knowledge of "self" and "non-self." Otherwise natural antibodies would be formed against self-constituents as well as foreign constituents.

We may therefore imagine that natural antibodies corresponding to both "non-self" and "self" constituents are at first formed by a random process of globulin synthesis. As the "self" constituents are formed during embryonic life, however, they combine with the corresponding natural antibodies and eliminate them. Only antibodies against "non-self" remain in circulation.

If, however, the animal is at the proper time exposed to very large quantities of a foreign antigen, the corresponding natural antibody would also be eliminated. That antigen is thereafter mistakenly recognized as "self," and antibodies will not be formed against it.

A hypothesis about pigs

With this background in mind, we can now consider observations that several investigators have made about pigs. Normally baby pigs can form antibodies after injection with a number of antigens. Baby pigs which have not been allowed to suckle the sow's colostrum, however, form little or no antibody after injection with the same antigens.

Pigs are born with very little serum globulin, acquiring large amounts of maternal globulin with the sow's colostrum. It therefore seemed possible that lack of maternal globulin might cause the inability of colostrum-deprived pigs to form antibodies. Being deficient in serum globulin, these pigs might not have a full complement of natural antibodies and therefore might not possess the recognition mechanism necessary for antibody formation. By suckling colostrum, however, the baby pigs would acquire the maternal globulin containing the natural antibodies and immunologic recognition mechanism.

Through normal catabolic processes, the pigs would in time eliminate the colostrum-derived maternal natural antibodies. In the meanwhile, the pigs would start making their own natural antibodies, so that they wouldn't need the maternal recognition mechanism by the time it was worn out.

Hypothesis tested

The above hypothesis has been tested experimentally in the College of Veterinary Medicine. In the first experiment, a group of colostrum-fed pigs and a group of colostrum-deprived pigs were each injected with two antigens, diphtheria and tetanus toxoids. Another group of colostrum-deprived pigs received the same antigens mixed with specific antibodies from the serum of older hogs which had been injected repeatedly with the toxoids. Because natural antibodies are not detectable in normal blood serum, the serum from the older hogs had been diluted until antibodies were no longer detected.

Pigs which had received the serum produced more antibody than the other colostrum-deprived pigs, and nearly as much antibody as the colostrum-fed pigs. A small quantity of preformed antibody had apparently replaced the effect of colostrum.

This experiment was repeated with variations to make sure that the observed effect was indeed due to the specific antibodies. When one of the two antibodies was removed from the diluted immune serum, the colostrum-deprived pigs did not make the corresponding antibody, but they still made the type of antibody that was left in the preparation. When the immune serum was produced in a different species, the horse, the antibody-stimulating effect was still observed.

Other questions asked

The next phase of the work attempted to answer another question. It had been postulated that even colostrum-deprived pigs would, as they became older, make their own natural antibodies. These pigs should therefore produce more antibody if injected with antigen and the serum globulin of older, non-immunized, colostrum-deprived pigs. Experimental results confirmed the prediction.

Another question arose at this point: Where do the natural antibodies come from? It had been reported recently that the thymus, an organ which is active in the young but regresses in the adult, plays a major role in the process known as immunologic maturation. If the thymus is removed surgically at an early age, the operated animal cannot form antibodies. It was therefore thought that natural antibodies might be formed by the thymus of young animals.

To test this possibility, colostrum-deprived baby pigs were injected with diphtheria and tetanus toxoids mixed with an extract prepared by grinding the thymuses of other pigs in water. After this treatment, the colostrum-deprived baby pigs could produce antibodies. Similar results were obtained when extracts of rabbit thymus were used. Furthermore, globulin was found in the thymus extracts.

Further experimentation

Although the theory of the immunologic recognition mechanism has not yet been proven, the experimental evidence is in accord with the theory. The theory has permitted the formulation of certain predictions, which were later confirmed by the experiment. More predictions can be made, and more experimentation is in progress. Ultimately, with the aid of other investigators, the mystery of those remarkable proteins, the antibodies, will perhaps be elucidated.

MINERAL LEVELS IN SERUM OF MILK-FEVER COWS

at Time of Treatment and During Lactation

K. A. KENDALL and K. E. HARSHBARGER

MILK FEVER (parturient paresis) in dairy cows has been known and studied for many years.

Although many theories have been advanced as to the exact cause for this disorder, the real underlying cause or causes remain thus far unexplained. In general, high-producing cows are more likely to be afflicted than low producers. There are, however, exceptions to this rule.

While we don't know the cause of milk fever, we have learned a great deal about mineral levels in the blood serum of parturient cows that become afflicted with this disorder. The blood-serum calcium drops markedly and there is an even greater proportionate drop in blood-serum inorganic phosphorus.

But what happens to the blood components of cows with paretic histories while they are in heavy flow of milk or later, when rate of milk secretion has begun to decline? Since little attention has been paid to this question, we have attempted to find some answers.

One purpose of our study was to find a way of identifying cows with borderline levels of calcium and phosphorus. Such cows do not show symptoms of milk fever at one calving but may develop symptoms at the next parturition. With more knowledge about blood-serum mineral levels of paretic cows, we should be able to identify the suspects and be prepared to treat them promptly.

Six cows observed

Observations were made of six cows that showed many of the typical symptoms of milk fever. These symptoms included depression, a tendency to lie down, tremors, unsteady gait, head lying to one side of the body, and varying degrees of tetany ranging from partial paralysis to almost complete inability to move.

The six cows developed symptoms between 6 and 12 hours after calving. This is when milk-fever symptoms usually appear, although they may not show up until 24 to 36 hours after a cow has calved.

Jugular blood samples were taken from the afflicted cows. Serum levels of calcium, inorganic phosphorus, sodium, potassium, and blood sugars or total reducing substances (T.R.S.) were determined according to standard procedures.

The same determinations were made later while the cows were in

K. E. Harshbarger, Professor of Nutrition i Dairy Science Department, and K. A. Ke Professor of Dairy Science, test blood-s samples for inorganic phosphorus. Joseph H Ronald Camden, and Robert Morrissey s as technical assistants on the study.

the first part of their lactation periods, and also when they were near the end of lactation. In each of these two periods, the cows were bled either on 5 consecutive days or on 5 days in the same week. This was done to study day-by-day variations in the blood components.

Levels of the different blood components at the time of the attack,

Table 1. — Blood-Serum Components in Parturient Paretic Cows Immediately Before Calcium Glucanate Treatment[a] and During Lactation

Cow	Calving No.	Pretreatment levels					Levels during lactation					5-day aver. milk	No. of lactation
		Calcium	Phosphorus	Sodium	Potassium	T.R.S.[b]	Calcium	Phosphorus	Sodium	Potassium	T.R.S.[b]		
		mg. per 100 ml. of serum					*mg. per 100 ml. of serum*					*lb.*	
1562[c]	6	5.4	1.35	323	20.3	63	9.7	3.40	335	19.8	59	68	2
1515	6	5.9	.24	338	17.1	62	9.2	3.89	337	18.7	60	49	4
1532	6	4.7	1.28	345	18.9	48	10.4	3.39	349	19.0	58	51	4
1555[c]	5	5.8	.90	345	16.6	55	10.6	5.02	348	23.1	57	18	9
1455	7	5.9	1.68	312	23.4	94	11.9	5.14	343	23.4	43	30	9
1612	5	5.7	.45	456	19.1	54	11.5	4.74	353	21.2	39	52	5
Aver.		5.6	.98	335	19.2	63	10.5	4.26	344	21.0	53	..	..

[a] Levels were determined within 10 minutes of calcium administration.
[b] T.R.S. = total reducing substances (blood sugars).
[c] Cows 1562 and 1555 required two or more injections of calcium gluconate.

just before the administration of calcium gluconate, are shown in Table 1. In each cow, symptoms were alleviated within an hour after the first injection. Cows 1562 and 1555, however, suffered relapses and had to have two or more injections before they recovered completely.

Also shown in Table 1 are 5-day average levels for each cow at some period during lactation. For three of the cows, the levels found during the first four months of lactation are shown. Levels for the other three cows are those obtained during later stages of lactation.

Levels rise after treatment

Certain trends are observed when one compares the blood-serum composition of the cows during lactation with the composition at the time of the attack (Table 1). The average calcium level during lactation was nearly twice as high as before the calcium gluconate treatment; and the phosphorus level was more than four times as high.

At the time of the milk fever attack, the average ratio of blood-serum phosphorus to calcium in the six cows was 1:5.6. As would be expected, this relationship shifted during lactation. The average ratio of phosphorus to calcium was 1:2.5 for the various stages of lactation represented in the table.

Sodium and potassium levels averaged very little more during lactation than during the milk fever attack. Average T.R.S. levels were about 16 percent less during lactation.

Changes during lactation

It is interesting to note that the phosphorus levels in the serum increased during lactation. Cow 1562, during her second month of lactation, had 3.40 milligrams of phosphorus per 100 milliliters of serum. Cows 1515 and 1532 had levels of 3.89 and 3.39 milligrams, respectively, during the fourth month. By contrast, the levels for cows 1612 (fifth month), 1555 (ninth month), and 1455 (ninth month) were 4.74, 5.02, and 5.14 milligrams, respectively.

These data would suggest that as a milk-fever suspect advances in lactation, the serum-phosphorus level increases. Whether this is true of cows without paretic histories cannot be answered here.

Calcium levels during lactation followed the same general pattern as phosphorus levels, tending to increase as lactation advanced. The percentage increase for calcium, however, was not as great as for phosphorus.

The blood T.R.S. average values, on the other hand, were lower after the fourth month of lactation than they were earlier.

Table 2. — Daily Variations, During Two 5-Day Periods in the Blood-Serum Components of Three Lactating Cows With Milk Fever Histories

Date, 1962	Calcium	Phosphorus	T.R.S.	Milk per day	Date, 1962	Calcium	Phosphorus	T.R.S.	Milk per day
Cow 1562 (calved 1/25/62)									
	mg. per 100 ml.			lb.		mg. per 100 ml.			lb.
3/21	10.4	3.24	64	69	6/26	10.4	4.45	35	..[a]
3/22	7.2	2.38	64	68	6/27	10.7	4.64	39	..
3/23	11.2	3.78	61	67	6/28	10.3	5.08	39	..
3/24	10.0	4.16	55	74	6/29	10.4	4.69	41	..
3/26	9.6	3.46	49	65	6/30	10.6	4.99	44	..
Aver.	9.7	3.40	59	68	Aver.	10.5	4.77	40	..
Cow 1515 (calved 11/15/61)									
3/21	8.6	3.46	69	51	6/26	9.8	4.40	33	32
3/22	9.6	2.97	67	49	6/27	9.8	4.35	33	31
3/23	10.4	4.39	52	49	6/28	10.2	3.91	33	30
3/24	7.9	4.54	63	46	6/29	10.2	3.86	44	30
3/26	9.4	4.11	48	51	6/30	11.4	4.16	38	30
Aver.	9.2	3.89	60	49	Aver.	10.2	4.14	36	30
Cow 1532 (calved 11/29/61)									
3/21	10.0	2.22	59	53	6/26	9.7	4.60	35	34
3/22	10.1	3.73	57	49	6/27	9.6	4.30	29	33
3/23	11.3	4.00	59	46	6/28	9.6	4.74	35	31
3/24	9.9	4.05	63	57	6/29	9.8	4.50	47	28
3/26	10.5	2.97	51	51	6/30	9.9	4.40	41	30
Aver.	10.4	3.39	58	51	Aver.	9.7	4.50	37	31

[a] Cow 1562 dried off after 111 days because of mastitis.

Variations in levels

Day-to-day variations in the blood values of three of the cows are presented in Table 2. Values for two 5-day periods spaced 3 months apart are given for each cow.

Immediately it can be seen that both calcium and phosphorus varied more during the March 21-26 period than during June 26-30. In both periods T.R.S. levels varied less than calcium and phosphorus.

Average phosphorus levels in all three cows were markedly higher in June than in March. In two of the cows, calcium levels were also higher in June. T.R.S. levels dropped sharply between March 21-26 and June 26-30.

Cow 1562, which was not lactating during the June 25-30 period, showed much more day-to-day uniformity in levels of calcium, phosphorus, and T.R.S. than the other cows.

Summary

During an attack of milk fever, serum calcium and phosphorus levels drop sharply from normal values, with phosphorus showing much the greater decline. T.R.S. levels appear to rise above normal. Sodium and potassium, however, remain relatively constant.

With advancing lactation, serum calcium and phosphorus levels tend to increase while T.R.S. levels tend to drop, reaching a low of about 40 milligrams per 100 milliliters.

Women's narrow heels speed search for more durable floors

FOREIGN WOODS TESTED FOR FLOORING

C. S. WALTERS

Wood floors have a warmth, beauty, and individuality unsurpassed by any other material. Two floors may be of the same wood but have an entirely different appearance because of the character that Nature builds into each strip of flooring.

Search for new woods

A constant search goes on for new species or new treatments for wood already in use that will provide an even wider range of colors and grains.

But beauty isn't enough for modern flooring, particularly in public buildings. Women's spike or stiletto heels have created a need for much greater resistance to wear.

Theoretically, a 120-pound woman who supports herself on a single stiletto heel exerts a pressure of about 2,000 pounds per square inch (p.s.i.) on the floor (Fig. 1A). Women rarely walk flat-footed, however, so the weight is distributed over only a portion of the surface of the cocked heel — perhaps only 1/64 square inch (Fig. 1B). Thus, the "walking stress" for the 120-pound lady increases to nearly 8,000 p.s.i. If a woman weighs over 120 pounds, the stress and problem increase proportionately. It is small wonder that wood, tile, and even metal floors are hammered to the point where they need to be refurbished or even replaced at unreasonably short intervals.

The natural consequence of this wear has been a sharp increase in the cost of maintaining floors in public buildings. Much has been written about the problem, but as yet there has been no practical solution.

One cannot expect women always to wear flat heels, which would reduce the stress by distributing the load over a larger bearing surface. Certainly the problem cannot be solved by government fiat. No administrator would subject himself to the reaction of his lady constituents by requiring them to remove their "heels" as they enter public buildings.

One possible solution is the use of denser species. Two species from the southwest Pacific area — paldao (*Dracontomelum dao*) and Borneo crowntree (*Kingiodendron* spp.) — were recently recommended as possible flooring for new University buildings. At the request of the University architects, the Forestry Department has tested and evaluated both of these species.

Hardness tests

Small samples of paldao and crowntree were submitted to standard hardness tests along with two domestic species. The machine used is shown in Figure 2. It measures the load required to force a 0.444-inch steel ball into the wood to half the diameter of the ball. A greater load is needed to sink the ball into dense woods than into soft or "light" woods. The greater the density of wood, the greater is its resistance to wear.

Here are the results of the hardness tests:

Species	*Pounds*
Cherry, black	1,450
Crowntree	1,040
Crowntree	1,020
Oak, white	1,390
Paldao	2,270
Paldao	2,190

According to the above figures, paldao is somewhat more resistant to wear than white oak. Crowntree is probably too soft for flooring.

Dimensional stability

Good flooring must be stable — that is, it should not warp, shrink, or swell excessively as the relative humidity in the building changes. Shrinking or swelling in thickness is not as troublesome as changes in the width of the board.

Wood shrinks when it dries, and swells when it gets wet and adsorbs moisture from the atmosphere.

Weight concentrated on the left heel means a pressure on the floor of about 2,000 pounds per square inch, assuming the woman weighs 120 pounds. (Fig. 1A)

When walking, the woman exerts nearly four times as much pressure with her cocked heel as when she is standing with the heel square on the floor. (Fig. 1B)

C. S. Walters, Professor of Wood Technology and Utilization, Forestry Department, tests hardness of sample flooring block. The machine measures the load required to force half of a steel ball into the wood. (Fig. 2)

Flooring should therefore be installed at about the same moisture content as it will have in service. When the house is warm and dry during the winter, wood with too much moisture will shrink. In spring and summer, when relative humidity increases in Illinois, flooring installed at too low a moisture content will swell.

Small changes in width can be tolerated. Too much shrinkage, however, causes large cracks which soon collect dirt, finish, or wax, making the floor unattractive. Flooring that swells too much will warp and buckle.

In general, shrinkage across the board in a plane parallel to the growth rings (tangential shrinkage) is about double that in a plane perpendicular to the growth rings (radial shrinkage). For this reason, flooring is usually "quarter-sawed," so that the growth rings are arranged in a vertical pattern.

Tangential and radial shrinkage were measured in paldao, crowntree, and three other species that were dried from green to oven-dry (no moisture) condition. Crowntree appeared to have somewhat less tangential shrinkage than paldao, but the two species had about the same amount of radial shrinkage. Both species compared favorably with the native woods in total dimensional changes.

Since only single specimens were measured in our laboratory, the average dimensional changes of native species, based on hundreds of measurements by the U. S. Forest Products Laboratory, are shown in parentheses in Table 1. The variations between the average and the individual results are not unusual. Dimensional change can vary for individual samples taken from the same tree, as well as for those taken from different trees.

Specific gravity

The specific gravity or relative density of a wood is a good indicator of its hardness, machinability, strength as a column or beam, and many other physical and mechanical properties. All other factors being equal, the higher the specific gravity, the higher the resistance to wear.

Crowntree was found to be similar in specific gravity to cherry, walnut, and white oak. The sample of cherry we tested had a somewhat higher specific gravity than average, while the walnut sample had a below-average specific gravity. Paldao was considerably denser than the other woods. Of our native woods, shagbark hickory would be comparable in specific gravity.

Foreign vs. native woods

Judging from tests of a few samples, paldao seems better for flooring than crowntree, which is probably too soft. Both would be acceptable from the standpoint of shrinkage. The samples submitted for test were too small to reach any conclusions with regard to warp. Paldao, however, appeared to have an interlocked grain that might make it warp more than crowntree and native woods such as oak and maple.

No information regarding cost of the foreign woods accompanied the samples. Exotic woods are generally expensive, however, sometimes costing up to five times more than native woods. In addition, we do not know how available paldao and crowntree are. Up to now, the woods have not been tried in University buildings.

Table 1. — Shrinkage of Wood Specimens Dried to Oven-Dry Moisture Content

Wood	Shrinkage percentage[a]	
	Radial	Tangential
Crowntree	4.6	6.6
Paldao	4.7	8.4
Cherry	6.1 (3.7)[b]	8.8 (7.1)
Walnut	5.0 (5.5)	6.2 (7.8)
White oak	2.6 (5.3)	7.1 (9.0)

[a] Percentages are based on green dimensions.
[b] Figures in parentheses are average values based on measurements of several hundred specimens by the U. S. Forest Products Laboratory.

Table 2. — Specific Gravity of Five Species, Based on Oven-Dry Weight and Oven-Dry Volume

Specimen	Weight, gm.	Volume, cc.	Specific gravity
Crowntree	13.507	23.55	.57
Crowntree	13.832	24.00	.58
Paldao	10.513	13.05	.80
Paldao	10.094	12.50	.81
Cherry	15.747	25.00	.63
Walnut	4.950	10.30	.48
White oak	7.264	11.90	.61

DIETS LOW IN PHOSPHORUS MAY BE TH

JULIA O. HOLMES, BEULA McKEY, and ELIZABETH SCHMITT

It has long been believed that tooth decay is caused by some imbalance in the diet of civilized man. Fossilized skulls of early man show no evidence of tooth decay, and primitive peoples of today don't have dental trouble until their eating habits are changed by civilization.

Some early studies

More than 30 years ago various investigators found that tooth decay can be prevented or arrested in children by consistently feeding them a diet that induces good growth and well-being. Such a diet includes a quart of milk, one egg, two or more vegetables, and fruits each day, plus meat or fish several times a week.

Three of the investigators (Boyd, Drain, and Stearns) concluded in 1933 that either phosphorus, calcium, or a combination of the two was the dietary factor that prevented tooth decay. In an institution where most of the children had sound teeth, five persistently developed cavities. It was found that these children were absorbing little calcium and phosphorus. When their absorption of these minerals was increased, tooth decay stopped.

A number of observations and investigations have indicated that phosphorus, rather than calcium, may be the dietary factor essential for sound teeth. In 1928 Lennox suggested that inadequate phosphorus in the diet caused the rampant tooth decay observed in certain areas of South Africa. In those areas, the soils and consequently the crops were low in phosphorus. When patients' diets were supplemented with 1 gram of sodium glycerophosphate daily, tooth decay was arrested. Unfortunately Lennox did not give many data to support his conclusions, so his theory received little credence.

Shortly afterwards, however, Agnew and Agnew reached similar conclusions. They noticed that there was very little tooth decay among tribesmen of Tibet and West China who ate a diet high in phosphorus. These investigators did not conduct experiments with the people, but they did work with albino rats. When phosphorus was added to a diet that would otherwise cause tooth decay, both the incidence and the extent of cavities were reduced.

About the same time, Klein and Shelling, also studying tooth decay in albino rats, reported that diets high in calcium and low in phosphorus allowed decay to develop, but diets low in calcium and high in phosphorus prevented decay.

None of these early reports received much attention from later investigators studying methods of producing and preventing tooth decay in experimental animals. After Klein and Shelling's report, 25 years passed before conclusive proof was provided that tooth decay in animals can be induced or retarded by varying the level of dietary phosphorus. This proof was then offered by several different investigators working with rats or hamsters.

The hypothesis that tooth decay decreases with an increase in dietary phosphorus must now be tested on human beings. Earlier this year Bibby and Averill reported that dicalcium phosphate apparently did not alleviate tooth decay in institutionalized children in New York. McClure and Muller, however, had previously reported that dicalcium phosphate did not prevent tooth decay in rats unless it was fed in conjunction with sodium chloride (common table salt). Under the supervision of the National Institutes of Health, children in four Indian Reservation schools in the Dakotas are now receiving dicalcium phosphate and sodium chloride. As yet no results have been published.

Purpose of study

Many more studies will be needed to prove or disprove the hypothesis. As a start, we undertook a preliminary survey to determine whether a relationship exists between the amount of phosphorus eaten by children and adolescents and the incidence and extent of tooth decay.

The general plan for the survey was (1) to secure the cooperation of children and adolescents (and their parents) in recording kinds and amounts of food eaten; (2) to estimate the amounts of phosphorus in the foods; (3) to get an estimate of tooth decay in the children and teenagers; and (4) to determine the statistical correlations between dietary phosphorus and tooth decay.

Champaign county was chosen as the locus for the study, partly for convenience, but mostly for the following reasons: The soil and water have a low fluoride content; the county does not have any programs for fluoridation of the drinking water; and there is a high incidence of dental decay in school children.

55 boys and girls in study

Some youngsters in the study had rampant tooth decay; others had little if any. The criterion for tooth decay was the number of new cavities that had developed during the preceding two years. For the boys, the number of new cavities ranged from 0 to 14; for the girls, from 0 to 40. Mean annual rate for new cavity formation was 1.1 for the boys and 2.4 for the girls.

It was originally planned to pair two children of the same age and sex, one having high tooth decay, the other low decay. However, of 69 diet records submitted by the boys and girls, only 55 were complete

Julia O. Holmes is Professor and Beula McKey, Assistant Professor of Nutrition. Elizabeth Schmitt is a graduate student in Foods and Nutrition. The authors gratefully acknowledge the cooperation of members of the Illini Dental Society.

AUSE OF TOOTH DECAY

enough to be useful. The idea of pairing the youngsters therefore had to be abandoned.

Of the 55 diet records, 19 were submitted by boys and 36 by girls. The boys were divided into three age groups: 7- to 10-year-olds; 12-year-olds; and 14- to 15-year-olds. The girls were classified into four age groups: 7-10; 11-12: 13-15; and 17-18.

The food record

The youngsters (or the parents) were supplied with standard forms for recording the foods eaten at all meals and between meals for seven consecutive days. Instructions were given to list every morsel of food eaten at home, in the school cafeteria, at parties, at restaurants, and so on.

We stressed the importance of continuing to eat the foods habitually eaten. If the food record was to be of any value it had to indicate the types and amounts of food eaten over many months.

Foods eaten at home were measured as precisely as possible. Standard measuring cups and measuring spoons were used for fluids and foods that could be poured or packed into the cup. Such foods as meat, cake, and pie were measured with a small plastic ruler. When several persons were served from complex mixtures of two or more foods, the recipes were requested from the parents. The quantity of each individual food was estimated and divided by the total number of servings. Foods eaten away from home were estimated as closely as possible.

The volumes of all the foods eaten during the week were converted to weights, which were then totaled and divided by 7 to obtain the daily average. The amount of phosphorus in the food eaten each day was estimated by referring to standard food composition tables. This procedure gave only approximations of the phosphorus intake; greater precision would not have been justified in a preliminary study.

Phosphorus intake

The amount of phosphorus eaten varied from 1.2 to 2.8 grams for the boys, and from 0.8 to 1.6 grams for the girls. For the boys, both calorie intake and phosphorus intake increased with age (see table). For the girls, however, the lowest calorie and phosphorus intakes were among the 17- to 18-year-olds. The low calorie intake in this group is consistent with physiological facts: When people stop growing, their caloric requirement falls. None of the boys had stopped growing.

The decrease in phosphorus intake with age of the girls merits further study with more girls.

Correlation with tooth decay

The data were analyzed to determine whether a correlation could be found between phosphorus intake and the number of cavities that had developed during the previous two years. A negative correlation would indicate a decrease in cavities with an increase in phosphorus (or conversely, an increase in cavities with a decrease in phosphorus). A positive correlation would indicate increased numbers of cavities with increased intakes of phosphorus.

Daily Phosphorus and Caloric Intake According to Sex and Age Group

Sex and age	Phosphorus	Calories
	grams	
Boys		
7-10	1.5	2,230
12	1.9	2,505
14-15	2.2	3,320
Girls		
7-10	1.4	1,890
11-12	1.3	2,080
13-15	1.3	2,245
17-18	1.0	1,880

PARENTS: For similar studies in the future, we need the cooperation of other children, particularly girls 10 or older and boys of 12 or more. Records of children with a high number of cavities will be especially useful. If you would be willing to have your children participate in such a study, will you please write Miss Beula McKey, 445 Bevier Hall, Urbana, Illinois?

In the seven age groups (three for the boys and four for the girls) the correlation coefficients ranged from +0.465 to −0.886. In five of the seven age groups the correlation coefficients were negative, suggesting that phosphorus might be the dietary factor that inhibits tooth decay. The trend was not pronounced, however, because of the great variability in response of the subjects. Moreover, with the small number of individuals in each age group, the results cannot be considered conclusive.

To secure a larger number of subjects for comparison, we tried classifying the youngsters according to physiological rather than chronological age. A group of 25 boys and girls were assumed to have reached the pubertal period of rapid growth when they would be experiencing the greatest need for dietary nutrients. For this group the correlation coefficient was −0.318, which was too low to be meaningful. However, it is still in the expected direction.

A trend indicated

A clear-cut relationship between the level of dietary phosphorus and formation of new cavities was not demonstrated in this preliminary survey. There was, however, a slight tendency for tooth decay to decrease with an increase in the amount of phosphorus eaten. This finding, together with the very conclusive data obtained in experimental animals, suggests that further study of this important problem might be fruitful.

Extension Service and other agencies cooperate in a NEW PROGRAM FOR LOW-INCOME FAMILIES

A nutrition workshop in Madison county is typical of those being conducted in Jackson, Franklin, and other counties. Home adviser Elaine Wendler conducts the meeting with the aid of local leader.

MILDRED NUTTALL

NEW educational programs, based on the conviction that human beings are America's most valuable resource, have been launched in several Illinois counties. The programs are possible through the cooperation of various individuals and organizations. Among them is the Cooperative Extension Service.

Planning in Jackson county

In Jackson county, the program originated at a meeting of the Welfare Services Committee in the fall of 1961. William Wanstreet, County Superintendent of the Department of Public Aid, voiced a concern that has long been felt by the Department: In certain families, poor standards and lack of skills are perpetuated through succeeding generations. Surely this pattern could be changed if people had the opportunity to develop their potential. As a first step, he suggested training homemakers in nutrition and housekeeping, and asked whether the Extension Service could help.

Assistant youth adviser Mildred Benz, a member of the committee, suggested a conference with Extension personnel. At this conference, plans were made to develop an intensive educational program for training women in basic nutrition and housekeeping practices. Aimed primarily at women in the low-income brackets, the program was to be for anybody who wanted to attend.

To plan the format of the sessions, the county Extension staff, the Area Resource Development adviser, and two caseworkers worked with a committee of women who wanted to attend the training program. This committee decided on the name of the program — Homemakers' Workshops, topics to be studied, hours for the meetings, plans for care of children, and transportation. In addition to the topics originally planned, the women also wanted to learn more about health and family relationships.

These women later helped actively with the workshops — in preparing for each meeting, assisting during the meetings, and cleaning up afterwards. They also invited their friends and acquaintances to the meetings.

Aims and format of workshops

As finally worked out, objectives of the workshops were to help homemakers (1) prepare simple meals that make the best use of available foods and meet the family's nutritional needs; (2) make better use of income through improved buying practices and better care of clothing and equipment; (3) improve housekeeping standards and management; and (4) improve family relationships.

Long-range goals for the women were: (1) acceptance of their roles as homemakers and citizens; (2) independent living; and (3) development of potential for employment if desirable.

Plans were made for a basic workshop that would consist of an afternoon meeting once a week for six weeks. Since then, the workshops have followed the same pattern. At every meeting, the use of surplus commodities is demonstrated and the food served to the group. Various topics are discussed — nutrition, meal planning and preparation, clothing, health, family relations, management and care of the home.

After these workshops were well under way, classes were organized to train some of the women as domestic workers. This training has been given in 12 three-hour sessions. Topics discussed have included cleaning and laundry methods, proper food handling, employer-employee relationships, and social security and employment registration. Home economists and other representatives of various organizations have been the instructors.

Between January 1 and July 1, 1963, two groups, totaling 55 women, received this course of instruction. By July 1, 22 of the women had found employment.

Franklin county

About the same time that Jackson county began its program, Franklin county started a similar one. Here the program developed as a means of giving nutritional information to families receiving aid under the Food Stamp Plan. As yet Franklin county is the only Illinois county participating in the plan.

Through the initiative of Mrs. Olive Hastie and her staff in the Department of Public Aid, and Ray

Esther Siemen, Extension clothing specialist, shows workshop participants how to cut out a garment.

One of the women, with local leader looking on, starts stitching on the sleeve of her dress.

Smeltzer of the Agricultural Marketing Administration, a planning committee was formed. It included representatives of the two abovementioned agencies, as well as of the Cooperative Extension Service, Public Health Department, Salvation Army, and General Assistance office.

The nutrition workshops, as organized by the committee, are open to all low-income families, regardless of whether they receive aid under the Food Stamp Plan. For the first workshop, Extension foods and nutrition specialists gave a week of concentrated training. Later workshops have consisted of one session a week for six weeks.

About 60 women attended the first two workshops. They didn't want to stop when the workshops were over. At their request, a clothing workshop was conducted by Extension clothing specialists, home adviser Shirley Whitchurch, and a local leader. Sixty women made dresses for themselves or their children. Later Miss Whitchurch directed another workshop to help the women with mending, altering, and caring for clothing.

Other workshops and training

In Saline county, Mrs. Dora Capel, home adviser, has held two workshops. At the first, basic homemaking practices were discussed and food demonstrations were given; at the second, 30 women each made a garment.

Programs similar to the ones described are also under way in Alexander, Johnson, Madison, Marion, Pope, Pulaski, Randolph, Sangamon, Vermilion, Wabash, Williamson, Winnebago, and Woodford counties.

After attending the workshops in Saline county, six women enrolled in a class for training licensed practical nurses, and several others are planning to enrol in the next class. One of the women was invited to attend the Governor's Conference on Youth.

Through Southeastern Illinois College, Saline county has also completed a course for power sewing machine operators. Eight members of the class had been in the workshops.

Cooperators

Some of the organizations and individuals cooperating in the county programs have already been mentioned. Many others deserve credit as well. Church groups, for example, have assisted with transportation and ministers have helped with discussion groups. Local businessmen have provided food, illustrative material, and facilities for demonstrations. Newspapers and radio stations have given publicity to the workshops.

Homemakers' Extension associations have helped with teaching, demonstrations, and care of children. Instructors at the workshops have included representatives of the Social Security Administration, Illinois State Employment Service, and county health departments, as well as students of Southern Illinois University.

The Southern Illinois Technical Action Panel, an advisory group made up of representatives of agricultural agencies, asked the counties to report on their programs at a meeting last year. Since that time the Panel has given its support and guidance to the program.

Evaluation

According to caseworkers with the Department of Public Aid, the programs have been well received. Women who have attended the workshops are making better use of the foods available to them and are preparing better meals. Their housekeeping standards have improved, and so have their attitudes and outlook on life. Most of them want to receive more training.

One county reported, "As we visit the mothers who attended our workshop and discuss future plans for retraining or employment, we find that they have a different attitude and want to be a part of the population that is self-supporting."

Mildred Nuttall, formerly area adviser for resource development in southern Illinois, is now assistant state leader of home advisers.

RESEARCH IN BRIEF

Soybean as a Host of the Stem Nematode Isolated From Onion

In recent studies, soybeans have been found to be susceptible to the onion race of stem nematode, *Ditylenchus dipsaci.*

Collections of this race were made in Cook county to study the host range. The soybean variety Harosoy proved to be an excellent host on the basis of nematode population increase and symptoms produced. Additional tests were initiated to record symptom development.

Four seeds of the Chippewa variety were planted in each of ten 6-inch pots containing autoclaved greenhouse potting soil (4 parts fine silt loam, 2 parts rotted manure, and 1 part sand). Five pots were infested at the time of planting by pouring an aqueous suspension of 1,000 preadult *D. dipsaci* onto the soil surface; five pots were left as nematode-free controls. The experiment was maintained in the greenhouse at 65° to 75° F.

A week after germination chlorotic (yellowish) areas developed on the cotyledons of plants in infested pots, causing a mottled appearance. Infected cotyledons were somewhat thicker than healthy ones and were more spongy to the touch.

Primary leaves of infected plants expanded 2 or 3 days later than those of healthy plants. Infected leaves were markedly deformed, with the blades having areas that were wrinkled, puckered, and yellowed. On some plants the deformed areas were small; on others, the whole leaf became deformed. Occasionally the deformed areas contained dead or necrotic spots which became holes as the leaves continued to grow. Extremely deformed leaves died and dropped off in 4 to 6 weeks. Deformity of trifoliate leaves was less frequent and usually less severe.

In some cases the plumule or terminal bud was killed. Often an axilliary bud from the cotyledonary node would then start terminal growth.

After 6 to 8 weeks, brown streaks developed on the stem below the leaves. In severe cases, the browning would spread until it covered the entire lower stem and would sometimes continue up the stem into the petioles of the primary and first trifoliate leaves. Browning was also observed in the pith.

Occasionally stem and petiole growth was retarded, resulting in stunted plants with rosetted crowns. At 4 weeks of age, infected plants were one-half to two-thirds as tall as nematode-free plants. A few plants died as a result of infection.

In a later experiment, similar although more severe symptoms developed on Harosoy soybeans when the inoculum level was increased to 5,000 preadult *D. dipsaci* per pot. Germination was not reduced in this test, but after 6 weeks all infected plants were dead. — *Dale I. Edwards and Donald P. Taylor*

Chippewa soybean seedlings at right show symptoms of *Ditylenchus dipsaci* 10 days after being planted in a pot infested with 1,000 preadult *D. dipsaci*; seedlings at left are growing in noninfested soil.

Design for Saving Tractor Fuel Without Losing Power

Can a gasoline tractor be made to use less fuel at light loads but still produce maximum power at full load? This question has been under study for some time in the Department of Agricultural Engineering.

The conclusion reached in the past was that greater part-load efficiency can be obtained with present equipment, but not without a loss in maximum power and possible damage to the engine. Modification of the present carburetion system seems necessary to get both economy and power.

It is well known that lean mixtures are needed for economy and rich mixtures for power. To achieve both economy and power, a carburetor was modified to have two jets — one fixed jet for economy and one jet operated by the engine vacuum for power. As the load on a tractor engine is increased, the opening of the throttle plate reduces the manifold vacuum. The reduction in vacuum is used to open the power jet and supply more fuel for maximum power.

It was found that the engine spark timing had to be advanced to prop-

Tractor engine with modified carburetor is tested on dynamometer to find a way of increasing economy without sacrificing power.

erly burn the leaner mixtures at part load. This spark advance was also controlled by the engine manifold vacuum. It was adjusted so that the distributor would advance the spark at the same time as the carburetor started to deliver a leaner mixture for lighter loads.

Final laboratory testing is now under way to determine the probable yearly fuel savings as well as other operational factors such as starting, idling, and reaction to sudden loads. The next step is to test the equipment on a tractor in the field. Studies will be designed to test reliability, maintenance periods, cold starting, and other operational factors which must be satisfactory under field conditions before the modified designs can be used on new tractors. — *Gary Stahl*

Dealer's Costs for Hauling Feed to Farms

The bulk feed truck is an indispensable piece of equipment for many firms supplying feed to their customers. Its use has increased with the expansion in average size of livestock enterprises in Illinois.

Many feed dealers have said that charges for feed delivery are not high enough to pay for operation of their bulk trucks. To find out more about input-output relationships in feed hauling, information was secured on truck use from a successful feed dealer in central Illinois.

During 26 working days in March, this firm's bulk truck was used as follows:

	Median[a]	*Most*	*Least*
Amount per day:			
Miles traveled	25½	47½	9½
Loads hauled	4	9	2
Customers served	5	9	3
Unloading points	10	19	5
Tonnage hauled	17	32	6
Average for month:			
Customers per load	1	3	1
Unloadings per customer per trip	2	6	1
Tons per load hauled	4	8	½
Tons per customer	3	8	½
Tons per unloading	1½	8	½
Miles traveled per load	5½	17½	1½

[a] Value of middle observation in range of data.

The wide range in daily use of the truck points up the dealer's problem in getting optimum use of the truck and driver. The truck's loaded capacity was 7 tons of bulk feed plus another ton of sacked feed. But only one-eighth of the loads were 6 or more tons, and half of the loads were less than 4 tons.

In 80 percent of the trips, only one customer was served. Although the truck has three compartments, three customers were served from one load in only 3 percent of the trips. Some customers received more than one type of feed on a trip, and often a compartment was only partly filled.

A high share of this firm's customers lived near the mill, as evidenced by the fact that over a third of the round trips were less than 5 miles, and only a sixth were 10 miles or more. When the driver was away from the mill, he spent nearly twice as much time at the farm as on the road.

Annual fixed costs (not including driver) for the truck were estimated at $1,600, or $5.33 a day for 300 days of use. This meant that fixed costs per ton hauled per day ranged from 17 to 89 cents, with an average of 32 cents. Assuming variable truck-operating costs to be 7 cents a mile, these amounted to 10½ cents a ton, or $1.78 for an average day. Driver's wages were more than twice the combined average fixed and variable truck-operating costs. — *R. J. Mutti and C. L. Dyer*

Distribution of Calcium and Magnesium in Milk Influences Behavior During Processing

The calcium and magnesium in milk are important not only for their nutritional value but also for the way in which their distribution affects the behavior of milk under processing conditions. These metals occur in milk in several forms: (1) as free ions, (2) as soluble complex ions with citrates, phosphates, and bicarbonates, and (3) as colloidal complexes with the various proteins, phosphates, and citrates.

The distribution of the metals among these various forms is determined by the composition of the

milk. This in turn depends upon breed and individuality of the cow, stage of lactation, feed, and udder infections. The distribution is also influenced by temperature, acidity development, and the concentration of the milk during processing.

How the metals are distributed is important in determining the time of rennet clotting and the strength of the clot; the stability of milk proteins during the manufacture of evaporated or sterile concentrated milk; effect of frozen storage on milk; feathering of cream in coffee; and shrinkage of ice cream.

While it has been known for some time that calcium and magnesium are associated with the large caseinate particles or micelles in the milk, it has not been known whether they are also associated with the smaller nonmicellular proteins in their natural state. To solve this problem we, in the Department of Food Science, investigated the electrophoretic properties of these proteins in their natural environment.

It is known that when calcium or magnesium forms a complex with a protein, the speed at which the protein moves in an electric field is reduced. We demonstrated that the velocity of the nonmicellular proteins increased when the calcium and magnesium ions in the natural milk system were replaced by sodium ions. This constitutes direct evidence of complex formation between these proteins and calcium and magnesium.

We still have to determine how much calcium and magnesium are bound by the nonmicellular proteins. Since no completely satisfactory method exists for quantitative measurement of the soluble and colloidal forms of calcium and magnesium, a search is in progress for such a test.

One approach is based on the hypothesis that soluble calcium and magnesium are removed very rapidly from milk by excess buffered ion-exchange resin, while removal of colloidal calcium and magnesium proceeds logarithmically with time. Should this hypothesis be true, it will be possible to differentiate between these two forms. A study could then be made of the factors influencing their distribution in milk and the relationship between this distribution and the behavior of milk during processing. — *R. McL. Whitney and H. A. Ntailianas*

Behavior of Tractors on Roadside Slopes

Having more than 14,000 miles of roadways to maintain, the Illinois Division of Highways has no small problem. With interstate highways adding 30 acres per mile and 40 acres per interchange, the Division must now establish and maintain roadside cover on more than 140,000 acres. What's worse is that this problem is not on the level! The slopes encountered vary from 0 to 50 percent, with the average being around 30 percent.

A study is now being conducted to ascertain the relative effects of the many factors governing the behavior of a tractor (conventional or otherwise) when operated on a side slope. Some of the parameters being considered are: (1) location of the center of gravity, (2) location of the wheels and general geometry of the vehicle and implement, (3) magnitude, direction, and location of the loads, (4) front and rear end drives, (5) front and rear end steering, and (6) torque inputs to each wheel.

For the first part of the study, a mathematical model is being constructed. The first analysis primarily involves the vehicle itself, with use of tire characteristics as they already exist. Ground deformation under the tractor's weight and certain other sod and soil characteristics are not being studied at present.

Several values for each parameter will be substituted into the derived equations. The equations of the mathematical model will predict the behavior of the tractor as it operates on the slope. Steepness of the slope will be increased until the tractor fails to operate properly. Failure may occur by tipping, sliding off the slope, or by loss of steering control, of traction, or of forward velocity. A digital computer will be used in the study. Eventually the tractor's behavior will be shown graphically.

Whether future roadside tractors are manned or operated remotely, the problem of operational stability will still exist. It is hoped that this investigation will point out the more critical parameters involved and lead to improved design and specifications for vehicles in the future. — *Roscoe L. Pershing*

The Division of Highways must maintain roadside cover on more than 140,000 acres, some of which is steeply sloping.

Growth Studies on an Organism That Causes Food Poisoning

To eliminate bacterial food poisoning, we first have to understand the manner in which the responsible organisms grow. Perhaps the most important of these organisms is the *Staphylococcus*. After a person eats food containing a large population of these bacteria, he usually develops a gastro-intestinal intoxication. This condition is seldom fatal, but the symptoms are commonly so severe that it seems never-ending.

We have investigated the effects of incubation temperature, acidity (pH), and sodium chloride (common salt) on a particular strain of *Staphylococcus aureus*. We found that this organism would grow at temperatures as low as 50° F. and as high as 113° F. The most favorable temperature for growth was 98.6° F. At temperatures below and above this optimum, the lag phase (period of adjustment) was lengthened, the rate of growth decreased, and maximum population decreased.

In similar experiments, the growth medium was modified with an intermediate amount of salt (4 percent) and a higher concentration of salt (8 percent). With the intermediate level of salt, the lag phase was longer than in the control or no-salt experiments, but the rate of growth was greater. Total population was about the same. With the higher concentration of salt, the lag phase was longer than at the 4-percent concentration; growth rate was lower than that of the control; and total viable population was decreased. The above relationships remained the same at a variety of temperatures.

To study the effect of acidity on the growth of these organisms, special methods were devised for controlling the pH of the growth medium during the incubation period. The organism grew best in neutral to slightly alkaline conditions, but it could withstand increased acidity better than increased alkalinity. In general, as pH varied in either direction from the optimum, the lag time increased and rate of growth decreased but total population remained constant. When the intermediate concentration of salt was added to the medium, results were similar to those obtained in the temperature study, but the increase in growth rate was more pronounced. At the 8-percent concentration of salt, results were also similar to those of the previous study.

We are now studying the mechanism by which salt stimulates the rate of growth. Also, we are considering additional experimentation to study the growth of this organism in association with other common, naturally occurring food microorganisms. — *John J. Iandolo and Z. John Ordal*

Measurements of Infiltration Rates Give Useful Information for Agricultural Engineers

During the past decade engineers, utilizing physical principles, have developed new methods of designing systems for flood and erosion control and for drainage operations. To use these methods effectively, we need to correct present deficiencies in our knowledge of water movement on and in the soil and to develop reliable, practical methods of estimating rates of water movement.

For example, predicting the rate of rainfall infiltration into a soil represents a problem for the design engineer that has not yet been satisfactorily solved. Advances are being made in this area, however, with the improvement of measuring techniques and equipment. It is now possible to obtain better infiltration data under field conditions than in the past.

The Departments of Agricultural Engineering and Agronomy are currently measuring infiltration rates for selected Illinois soils under simulated rainfall. The infiltration characteristics of a soil vary with the extent to which its surface is disturbed by the impact of a raindrop. Therefore water is being sprayed on test plots in such a way that size of water drops and impact energy are very like those for a high-intensity rainstorm. Other conditions affecting infiltration which are accounted for in the experiment are soil moisture before the rain, crop cover, apparent bulk density, and textural gradation of the soil.

In the past, infiltration studies by different organizations over a wide area have often varied so much in methodology and variables tested that the results could not be combined for greater usefulness. To avoid this shortcoming, the Illinois investigations are coordinated with those in other midwestern states. It is hoped ultimately to provide comparable information on infiltration for more than 30 major soil series. — *Richard Fenzl*

Apparatus used in studies of infiltration rates. Water is sprayed on the soil with the force of a high-intensity rainstorm.

FARM BUSINESS TRENDS

FARMING is a rapidly changing business. Constant study of the changes is essential for a profitable future. The chart on this page shows some of these changes — trends in cash receipts from the sales of leading farm products over the past 10 years.

The big six. Fifty years ago six groups of farm cash products were of about equal importance. These were cattle and calves, cotton, hogs, dairy products, feed crops, and food grains. These groups are still in the lead, but differences between them are much greater.

Cattle and calves. Cash receipts from the sale of cattle and calves exceeded receipts from any other product group in 1910-1914. They were among the top three until 1945, when they took over undisputed possession of first place. By the late 1950s cattle and calves had opened up a big lead over the other farm products. Farmers received $8,146 million from sales of cattle and calves in 1962.

Dairy products. Milk and cream ranked fourth as money winners back in 1910-1914. They took over first place in the late 1920s and held first by a big margin in the Great Depression of the 1930s. Sales of dairy products slipped into second place in 1945 and have held that position ever since. Income from dairying is more stable than income from many other farm products. The loss of much of the butter market, however, has hurt the dairy business.

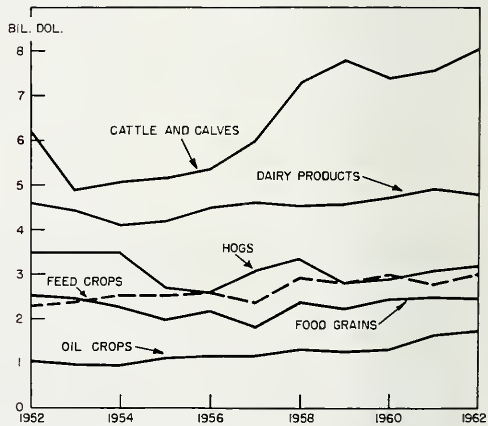
Hogs. Cash receipts from sales of hogs ranked third in 1910-1914. They have been third or close to it in each intervening year. Pork lost favor with consumers after World War II, but has held its position well since the middle 1950s.

Feed crops. Sales of feed crops, principally corn, were fifth among the big six a half century ago. Increasing export demand and the specialization of livestock and poultry production has made a rapidly increasing demand for the feed crops.

Food grains. Cash receipts from the sales of wheat, rye, and rice were the smallest of the big six in 1910-1914. They have been in sixth or fifth place in most of the past 50 years. They would drop lower except for government programs. Wheat and rice are our two most heavily subsidized farm products.

Cotton. Cash receipts from cotton, which ranked second a half century ago, are now fifth (not shown on chart).

Oilbearing crops. Cash receipts from oil crops, chiefly soybeans, have increased more than receipts from any other major farm product group. Sales increased 86 percent from 1954 to 1962. Soybean producers gain from increasing demand for soybean meal and from strong foreign markets for soybeans.



Cash receipts from marketings of leading farm products in the United States, 1952-1962.

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